

*Fort Bend County, Texas
Request for Proposals*



*Construction of Precinct 3 Annex
for Fort Bend County
RFP 23-026*

SUBMIT PROPOSALS TO:

Fort Bend County
Purchasing Department
Travis Annex
301 Jackson, Suite 201
Richmond, TX 77469

****NOTE:**

All correspondence must include the term
“Purchasing Department” in address to assist in
proper delivery

SUBMIT NO LATER THAN:

Tuesday, February 21, 2023
2:00 PM (Central)

MARK ENVELOPE:

RFP 23-026
Precinct 3 Annex

***ALL SUBMITTALS MUST BE RECEIVED AND TIME/DATE STAMPED BY THE PURCHASING OFFICE
OF FORT BEND COUNTY ON OR BEFORE THE SPECIFIED TIME/DATE STATED ABOVE.***

SUBMITTALS RECEIVED AS REQUIRED WILL THEN BE OPENED AND THE NAMES PUBLICLY READ.

SUBMITTALS RECEIVED AFTER THE SPECIFIED TIME WILL BE RETURNED UNOPENED.

Results will not be given by phone.
Results will be provided to bidder in writing
after Commissioners Court award.

Requests for information must be in
writing and directed to:
Brooke Lindemann
Senior Buyer
Brooke.Lindemann@fortbendcountytexas.gov

Vendor Responsibilities:

- Download and complete any addendums. (Addendums will be posted on the Fort Bend County website no
Later than 48 hours prior to bid opening)
- Submit response in accordance with requirements stated on the cover of this document.
- DO NOT submit responses via email or fax.



COUNTY PURCHASING AGENT

Fort Bend County, Texas

Vendor Information

Jaime Kovar
Purchasing Agent

Office (281-341-8640)

Legal Company Name <small>(top line of W9)</small>				
Business Name <small>(if different from legal name)</small>				
Federal ID # or S.S. #		DUNS #		
Type of Business	<input type="checkbox"/> Corporation/LLC <input type="checkbox"/> Partnership <input type="checkbox"/> Sole Proprietor/Individual <input type="checkbox"/> Tax Exempt Organization	Age in Business?		
Publicly Traded Business	<input type="checkbox"/> No <input type="checkbox"/> Yes Ticker Symbol _____			
Remittance Address				
City/State/Zip				
Physical Address				
City/State/Zip				
Phone/Fax Number	Phone: _____ Fax: _____			
Contact Person				
E-mail				
Check all that apply to the company listed above and provide certification number.	DBE-Disadvantaged Business Enterprise <input type="checkbox"/>	Certification # _____ Certification # _____ Certification # _____ Certification # _____	<u>Cert Date</u>	<u>Exp Date</u>
	SBE-Small Business Enterprise <input type="checkbox"/>		_____	_____
	HUB-Texas Historically Underutilized Business <input type="checkbox"/>		_____	_____
	WBE-Women's Business Enterprise <input type="checkbox"/>		_____	_____
			_____	_____
Company's gross annual receipts	<\$500,000 _____	\$500,000-\$4,999,999 _____		
	\$5,000,000-\$16,999,999 _____	\$17,000,000-\$22,399,999 _____		
	>\$22,400,000 _____			
NAICs codes (Please enter all that apply)				
Signature of Authorized Representative				
Printed Name				
Title				
Date				

THIS FORM MUST BE SUBMITTED WITH THE SOLICITATION RESPONSE

1.0 SCOPE OF WORK:

Fort Bend County, Texas (hereafter referred to as the “County”) seeks Proposals (“Proposals or RFP”) for selection of a Contractor (“Respondent”) to complete the construction of Precinct 3 Annex (“Project”), located in Sugar Land, Texas.

Vendor to construct new 25,145 square foot annex office building for Precinct 3 on Stadium Drive in Sugar Land, Texas within the Imperial Development. The facility will be a one story, pre-engineered, rigid frame structural system with a brick and stone facade and standing seam metal roofing. Parking will consist of concrete paving for approximately 170 vehicles and include extensive landscaping and irrigation. Interior finishes will include painted drywall, suspended and drywall ceilings, carpet, porcelain tile, and vinyl plank tile flooring.

2.0 GUIDELINES:

By virtue of submitting a proposal, interested parties are acknowledging:

- 2.1 The County reserves the right to reject any or all proposals if it determines that select proposals are not responsive to the RFP. The County reserves the right to reconsider any proposal submitted at any phase of the procurement. It also reserves the right to meet with select Respondents at any time to gather additional information. Furthermore, the County reserves the right to delete or add scope up until the final contract signing.
- 2.2 All Respondents submitting proposals agree that their pricing is valid for a minimum of ninety (90) days after proposal submission to the County. Furthermore, the County is by statute exempt from the State Sales Tax and Federal Excise Tax; therefore, proposal prices shall not include taxes.
- 2.3 This Proposal does not commit the County to award nor does it constitute an offer of employment or a contract for services. Costs incurred in the submission of this proposal, or in making necessary studies or designs for the preparation thereof, are the sole responsibility of the Respondents. Further, no reimbursable cost may be incurred in the anticipation of award. Proposals containing elaborate artwork, expensive paper and binding and expensive visual or other presentations are neither necessary nor desired.
- 2.4 In an effort to maintain fairness in the process, all inquiries concerning this procurement are to be directed only to the County’s Purchasing Agent in writing. Attempts to contact any members of the County’s Commissioners’ Court or any other County employee to influence the procurement decision may lead to immediate elimination from further consideration.
- 2.5 When responding to this Proposal, follow all instructions carefully. Submit proposal contents according to the outline specified and submit all hard copy and electronic documents according to the instructions. Failure to follow these

instructions may be considered a non-responsive proposal and may result in immediate elimination from further consideration.

3.0 PROPOSAL CONTACT:

This Proposal is being issued by the County Purchasing Agent on behalf of Fort Bend County, Texas. Thus, responses should be directed to the Purchasing Agent, as outlined below. **Respondents are specifically directed NOT to contact any County personnel for meetings, conferences or technical discussions that are related to this Proposal other than specified herein. Unauthorized contact of any County personnel will likely be cause for rejection of the Respondent's proposal. All communications regarding the Proposal shall be directed to the County's Proposal Contact.** Communication with the Proposal Contact is permitted via email, facsimile, or written correspondence.

PROPOSAL CONTACT:

Brooke Lindemann
Senior Buyer
Fort Bend County Travis Annex
301 Jackson, Suite 201
Richmond, Texas 77469
Brooke.Lindemann@fortbendcountytexas.gov
Phone: 281.344.3929

4.0 SUBMISSION REQUIREMENTS:

- 4.1 Submission requirements: one (1) original proposal is required by RFP opening time of 2:00 PM on Tuesday, February 21, 2023. Four (4) paper copies and one (1) electronic response on flash drive are required to be submitted to Purchasing by 9:00 AM on Wednesday, February 22, 2023. Flash drive must contain only one (1) file in PDF format and must match written response identically. Failure to provide proper flash drive is cause for disqualification. Proposal shall be submitted to the address shown below. Proposal shall be signed, in ink, by a person having the authority to bind the firm in a contract.

Fort Bend County	Proposal Number: R23-026
Purchasing Department	Due Date: February 21, 2023
301 Jackson, Suite 201	Time: 2:00 PM (CST)
Richmond, Texas 77469	For: Precinct 3 Annex

- 4.2 Respondents may submit their proposal any time prior to the Opening Date and time. The Respondent's name and address as well as a distinct reference to the Proposal number above shall be marked clearly on the submission. All proposals are time-stamped upon receipt and are securely kept, unopened, until the Opening Date. No responsibility will attach to the County, or any official or employee thereof, for the pre-opening of, post-opening of, or the failure to open a proposal

not properly addressed and identified. No oral, telegraphic, telephonic, or facsimile proposals will be considered.

- 4.3 Proposals may be modified or withdrawn prior to the established opening date by delivering written notice to the proposal contact. Any alteration made prior to opening date and time shall be initialed by the signer of the proposal, guaranteeing authenticity.
- 4.4 Proposals time-stamped after the due date and time will not be considered and will be returned to the Respondent unopened. Regardless of the method used for delivery, respondents shall be wholly responsible for the timely delivery of submitted proposals.
- 4.5 The Respondent's name and address shall be clearly marked on all copies of the proposal.

5.0 INCURRED COSTS:

Those submitting proposals do so entirely at their expense. There is no expressed or implied obligation by the County to reimburse any individual or firm for any costs incurred in preparing or submitting proposals, for providing additional information when requested by the County or for participating in any selection interviews, including discovery (pre-contract negotiations) and contract negotiations.

6.0 ACCEPTANCE:

- 6.1 Submission of any proposal indicates a Respondent's acceptance of the conditions contained in this Proposal unless clearly and specifically noted otherwise in their proposal.
- 6.2 Furthermore, the County is not bound to accept a proposal on the basis of lowest price, and further, the County has the sole discretion and reserves the right to cancel this Proposal, to reject any and all proposals, to waive any and all informalities and or irregularities, or to re-advertise with either the identical or revised specifications, if it is deemed to be in the County's best interests. The County reserves the right to accept or reject any or all of the items in the proposal, and to award the contract in whole or in part and/or negotiate any or all items with individual Respondents if it is deemed in the County's best interest.
- 6.3 Although Fort Bend County desires to negotiate toward a contract with a selected Respondent, the Commissioners' Court may award the contract on the basis of the initial proposals received, without discussions. Therefore, each initial proposal should contain the Respondent's best terms.

7.0 INTERPRETATIONS, DISCREPANCIES, AND OMISSIONS:

- 7.1 It is incumbent upon each potential Respondent to carefully examine these specifications, terms, and conditions. Should any potential Respondent find discrepancies, omissions or ambiguities in this Proposal, the Respondent shall at once request in writing an interpretation from the County’s Proposal Contact. Any inquiries, suggestions, or requests concerning interpretation, clarification or additional information shall be made in writing via e-mail only to the County’s Proposal Contact, as specified in Section 3.0. Deadline for submission of questions and/or clarification is **Wednesday, February 15, 2023 at 10:00 AM. (CST)**. Requests received after the deadline will not be responded to due to the time constraints of this Proposal process.

- 7.2 The issuance of a written addendum is the only official method by which interpretation, clarification or additional information will be given by the County. Only questions answered by formal written addenda will be binding. Oral and other interpretations or clarification will be without legal effect. If it becomes necessary to revise or amend any part of this Proposal, notice will be given by the County Purchasing Agent to all prospective Respondents who were sent a Proposal. The Respondent in their proposal shall acknowledge receipts of amendments. Each Respondent shall ensure that they have received all addenda and amendments to this Proposal before submitting their proposals.

8.0 TENTATIVE SCHEDULE:

Release of RFP:	January 29, 2023
Pre-RFP conference:	February 7, 2023
Deadline for Questions:	February 15, 2023
Submission Due Date:	February 21, 2023
Evaluation of Submissions:	Week of February 26 th
Commissioners Court Permission to Negotiate:	March 14, 2023
Negotiations:	Beginning March 15, 2023
Final Contract Approval Commissioners Court:	April 11, 2023

9.0 PRE-RFP CONFERENCE:

A Pre-RFP conference will be conducted on **Tuesday, February 7 at 9:30 AM** (central). The pre-RFP conference will be held at the Fort Bend County Purchasing Department located in the Travis Annex at 301 Jackson, Suite 201, Richmond, Texas 77469. All vendors are encouraged to attend. A site visit will be conducted after the conference, if necessary.

10.0 RETENTION OF RESPONDENT’S MATERIAL:

The County reserves the right to retain all proposals regardless of which response is selected. All proposals and accompanying documents become the property of the County.

11.0 CERTIFICATE OF INDEPENDENT PRICE DETERMINATION:

By submission of a proposal, each Respondent certifies, that in connection with this procurement:

- 11.1 The prices in this proposal have been arrived at independently, without consultation, communication, or agreement with any other Respondent; with any competitor; or with any County employee(s) or consultant(s) for the purpose of restricting competition on any matter relating to this Proposal.
- 11.2 Unless otherwise required by law, the prices which have been quoted in this proposal have not been knowingly disclosed by the Respondent and will not knowingly be disclosed by the Respondent prior to award directly or indirectly to any other Respondent or to any competitor; and;
- 11.3 No attempt has been made or will be made by the Respondent to induce any other person or firm to submit or not to submit a proposal for the purpose of restricting competition.

12.0 ASSIGNMENT:

The Respondent may not sell, assign, transfer or convey the contract resulting from this Proposal, in whole or in part, without the prior written approval from Fort Bend County Commissioners' Court.

13.0 CONFIDENTIAL MATTERS:

- 13.1 All data and information gathered by the Respondent and its agents, including this Proposal and all reports, recommendations, specifications, and data shall be treated by the Respondent and its agents as confidential. The Respondent and its agents shall not disclose or communicate the aforesaid matters to a third party or use them in advertising, publicity, propaganda, and/or in another job or jobs, unless written consent is obtained from the County.
- 13.2 Proposals will only be publicly received and acknowledged only so as to avoid disclosure of the contents to competing Respondents and kept secret during negotiation. However, all proposals shall be open for public inspection after the contract is awarded. Trade secrets and any material that is considered to be confidential information contained in the proposal and identified by Respondent as such will be treated as confidential to the extent allowable in the Open Records Act.

14.0 LIMITS OF SUBCONTRACTORS:

- 14.1 The County has approval rights over the use and/or removal of all subcontractors and/or vendor(s). Subcontractors shall conform to all County policies.

- 14.2 Any dispute between the Respondent and subcontractors, including any payment dispute, will be promptly remedied by the Respondent. Failure to promptly remedy or to make prompt payment to subcontractor may result in the withholding of funds from the Respondent by the County for any payments owed to the subcontractor.

15.0 JURISDICTION, VENUE, CHOICE OF LAW:

This Proposal and any contract resulting there from shall be governed by and construed according to the laws of the State of Texas. Should any portion of any contract be in conflict with the laws of the State of Texas, the State laws shall invalidate only that portion. The remaining portion of the contract(s) shall remain in effect. Any lawsuit shall be governed by Texas law and Fort Bend County, Texas shall be the venue for any action or proceeding that may be brought or arise out of, in connection with or by reason of this Proposal process and resulting Agreements.

16.0 INDEPENDENT CONTRACTOR:

The Respondent is an independent contractor and no employee or agent of the Respondent shall be deemed for any reason to be an employee or agent of the County.

17.0 AMERICANS WITH DISABILITIES ACT (ADA)

Proposals shall comply with all federal, state, county, and local laws concerning this type of products/service/equipment/project and the fulfillment of all ADA requirements.

18.0 DRUG-FREE WORKPLACE:

All Respondents shall provide any and all notices as may be required under the Drug-Free Workplace Act of 1988, 28 CFR Part 67, Subpart F, to their employees and all sub-contractors to insure that the County maintains a drug-free workplace.

19.0 PERFORMANCE AND PAYMENT BOND:

The Respondent shall post with Fort Bend County, not later than ten (10) days of the County's award of a contract, a performance and payment bond in the amount of one hundred percent (100%) of the total lump sum price in such form as is satisfactory by County. This bond shall be executed by a corporate surety company duly authorized and admitted to do business in the State of Texas and licensed to issue such a bond in the State of Texas. The Respondent shall notify its corporate surety of any contract changes.

20.0 POWER OF ATTORNEY:

An attorney-in-fact who signs a bid bond, performance bond or payment bond must file with each bond a certified and effectively dated copy of his or her power of attorney.

21.0 TEXAS ETHICS COMMISSION FORM 1295:

21.1 Effective January 1, 2016 all contracts executed by Commissioners Court, regardless of the dollar amount, will require completion of Form 1295 "Certificate of Interested Parties", per the new Government Code Statute §2252.908. All firms submitting a response to a formal Bid, RFP, SOQ or any contracts, contract amendments, renewals or change orders are required to complete the Form 1295 online through the State of Texas Ethics Commission website. Please visit:

https://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm.

21.2 On-line instructions:

21.2.1 Name of governmental entity is to read: Fort Bend County.

21.2.2 Identification number use: RFP 23-026

21.2.3 Description is: Precinct 3 Annex

21.3 Apparent low bidder(s) will be required to provide the Form 1295 within three (3) calendar days from notification; however, if your company is publicly traded you are not required to complete this form.

22.0 INSURANCE:

22.1 All respondents shall submit, with RFP, a current certificate of insurance indicating coverage in the amounts stated below. In lieu of submitting a certificate of insurance, respondents may submit, with RFP, a notarized statement from an Insurance company, authorized to conduct business in the State of Texas, and acceptable to Fort Bend County, guaranteeing the issuance of an insurance policy, with the coverage stated below, to the firm named therein, if successful, upon award of this Contract.

22.2 At contract execution, contractor shall furnish County with properly executed certificates of insurance, which shall evidence all insurance required and provide that such insurance shall not be canceled, except on 30 days prior written notice to County. Contractor shall provide certified copies of insurance endorsements and/or policies if requested by County. Contractor shall maintain such insurance coverage from the time Services commence until Services are completed and provide replacement certificates, policies and/or endorsements for any such insurance expiring prior to completion of Services. Contractor shall obtain such insurance written on an Occurrence form (or a Claims Made form for Professional Liability insurance) from such companies having Best's rating of A/VII or better, licensed or approved to transact business in the State of Texas, and shall obtain such insurance of the following types and minimum limits:

- 22.2.1 Workers' Compensation insurance. Substitutes to genuine Workers' Compensation Insurance will not be allowed.
- 22.2.2 Employers' Liability insurance with limits of not less than \$1,000,000 per injury by accident, \$1,000,000 per injury by disease, and \$1,000,000 per bodily injury by disease.
- 22.2.3 Commercial general liability insurance with a limit of not less than \$1,000,000 each occurrence and \$2,000,000 in the annual aggregate. Policy shall cover liability for bodily injury, personal injury, and property damage and products/completed operations arising out of the business operations of the policyholder.
- 22.2.4 Business Automobile Liability coverage with a combined Bodily Injury/Property Damage limit of not less than \$1,000,000 each accident. The policy shall cover liability arising from the operation of licensed vehicles by policyholder.
- 22.3 County and the members of Commissioners Court shall be named as additional insured to all required coverage except for Workers' Compensation and Professional Liability (if required). All Liability policies including Workers' Compensation written on behalf of contractor, excluding Professional Liability, shall contain a waiver of subrogation in favor of County and members of Commissioners Court.
- 22.4 If required coverage is written on a claims-made basis, contractor warrants that any retroactive date applicable to coverage under the policy precedes the effective date of the contract; and that continuous coverage will be maintained or an extended discovery period will be exercised for a period of two (2) years beginning from the time that work under the agreement is completed.
- 22.5 Builder's Risk Insurance: Contractor is required to provide proof before a Purchase Order is issued for this project and keep in full force and effect until the Transfer Date, Builders Risk Insurance, subject to policy terms and conditions, of direct physical loss or damage to property, materials, equipment and supplies which are to become an integral part of the Project, whether owned by Contractor, or subcontractors of every tier, and in which one or more of same has an insurable interest, while in transit, while at the Construction Site awaiting construction, during construction, and until the Transfer Date. Such insurance shall be maintained to cover, as nearly as practicable, the insurable value of such property, materials, equipment and supplies at risk, and shall contain a waiver of subrogation in favor of Contractor, Architect, subcontractors of any tier and Owner for loss or damage occurring during the Work and shall name Contractor as the named insured and Owner as additional insureds. All Builder's Risk Insurance proceeds shall be paid directly to the Contractor.

23.0 INDEMNIFICATION:

Respondent shall save harmless County from and against all claims, liability, and expenses, including reasonable attorney's fees, arising from activities of Respondent, its agents, servants or employees, performed under this agreement that result from the negligent act, error, or omission of Respondent or any of Respondent's agents, servants or employees.

- 23.1 Respondent shall timely report all such matters to Fort Bend County and shall, upon the receipt of any such claim, demand, suit, action, proceeding, lien or judgment, not later than the fifteenth day of each month; provide Fort Bend County with a written report on each such matter, setting forth the status of each matter, the schedule or planned proceedings with respect to each matter and the cooperation or assistance, if any, of Fort Bend County required by Respondent in the defense of each matter.
- 23.2 Respondent's duty to defend, indemnify and hold Fort Bend County harmless shall be absolute. It shall not abate or end by reason of the expiration or termination of any contract unless otherwise agreed by Fort Bend County in writing. The provisions of this section shall survive the termination of the contract and shall remain in full force and effect with respect to all such matters no matter when they arise.
- 23.3 In the event of any dispute between the parties as to whether a claim, demand, suit, action, proceeding, lien or judgment appears to have been caused by or appears to have arisen out of or in connection with acts or omissions of Respondent, Respondent shall never-the-less fully defend such claim, demand, suit, action, proceeding, lien or judgment until and unless there is a determination by a court of competent jurisdiction that the acts and omissions of Respondent are not at issue in the matter.
- 23.4 Respondent's indemnification shall cover, and Respondent agrees to indemnify Fort Bend County, in the event Fort Bend County is found to have been negligent for having selected Respondent to perform the work described in this request.
- 23.5 The provision by Respondent of insurance shall not limit the liability of Respondent under an agreement.
- 23.6 Respondent shall cause all trade contractors and any other contractor who may have a contract to perform construction or installation work in the area where work will be performed under this request, to agree to indemnify Fort Bend County and to hold it harmless from all claims for bodily injury and property damage that arise may from said Respondent's operations. Such provisions shall be in form satisfactory to Fort Bend County.
- 23.7 Loss Deduction Clause - Fort Bend County shall be exempt from, and in no way liable for, any sums of money which may represent a deductible in any insurance policy. The payment of deductibles shall be the sole responsibility of Respondent

and/or trade contractor providing such insurance.

24.0 PREVAILING WAGES:

This project is subject to the prevailing wage rate requirements of Chapter 2258 of the Government Code. All persons employed by Contractor shall be compensated at not less than the rates shown below. Contractor shall keep detailed records of each of its workers and said records shall be made available to County for inspection at all reasonable times. The Contractor shall pay Fort Bend County sixty dollars (\$60.00) for each worker employed by the Contractor for the provision of services described herein for each calendar day or part of the day that the worker is paid less than the below stated rates. Contractors may also visit www.wdol.gov/dba.aspx.

General Decision Number: TX20230247 01/13/2023

Superseded General Decision Number: TX20220247

State: Texas

Construction Type: Building

County: Fort Bend County in Texas.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022, Executive Order 14026 generally applies to the contract. The contractor must pay all covered workers at least \$16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022, Executive Order 13658 generally applies to the contract. The contractor must pay all covered workers at least \$12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/06/2023
1	01/13/2023

ASBE0022-009 06/01/2022	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR (Duct, Pipe and Mechanical System Insulation)	\$ 26.88	15.41
BOIL0074-003 01/01/2021 BOILERMAKER	\$ 29.47	24.10
CARP0551-008 04/01/2021 CARPENTER (Excludes Acoustical Ceiling Installation, Drywall Hanging, Form Work and Metal Stud Installation)	\$ 25.86	9.08
ELEC0716-005 08/30/2021 ELECTRICIAN (Excludes Low Voltage Wiring and Installation of Alarms)	\$ 33.20	10.37
* ELEV0031-003 01/01/2023 ELEVATOR MECHANIC	\$ 49.15	37.335+a+b

FOOTNOTES:

A. 6% under 5 years based on regular hourly rate for all hours worked. 8% over 5 years based on regular hourly rate for all hours worked.

B. Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; Friday after Thanksgiving Day; Christmas Day; and Veterans Day.

ENGI0450-002 04/01/2014		
POWER EQUIPMENT OPERATOR Cranes	\$ 34.85	9.85
IRON0084-002 06/01/2022 IRONWORKER (ORNAMENTAL AND STRUCTURAL)	\$ 26.76	7.88
PLAS0783-001 04/01/2021 PLASTERER	\$ 26.04	9.02
*PLUM0068-002 10/01/2022 PLUMBER	\$ 37.83	11.71

PLUM0211-010 10/01/2021

PIPEFITTER (Including HVAC Pipe Installation)	\$ 37.03	12.56
SHEE0054-003 04/01/2020		
SHEET METAL WORKER (Excludes HVAC Duct and Unit Installation)	\$ 29.70	13.85
*SUTX2014-023 07/21/2014		
ACOUSTICAL CEILING MECHANIC	\$ 16.41	3.98
BRICKLAYER	\$ 19.86	0.00
CAULKER	\$ 15.36**	0.00
CEMENT MASON/CONCRETE FINISHER	\$ 13.82**	0.00
DRYWALL FINISHER/TAPER	\$ 16.30	3.71
DRYWALL HANGER AND METAL STUD INSTALLER	\$ 17.45	3.96
ELECTRICIAN (Alarm Installation Only)	\$ 17.97	3.37
ELECTRICIAN (Low Voltage Wiring Only)	\$ 18.00	1.68
FLOOR LAYER: Carpet	\$ 20.00	0.00
FORM WORKER	\$ 11.87**	0.00
GLAZIER	\$ 19.12	4.41
INSULATOR – BATT	\$ 14.87**	0.73
IRONWORKER, REINFORCING	\$ 12.10**	0.00
LABORER: Common or General	\$ 10.79**	0.00
LABORER: Mason Tender – Brick	\$ 13.37**	0.00
LABORER: Mason Tender - Cement/Concrete	\$ 10.50**	0.00
LABORER: Pipelayer	\$ 12.94**	0.00
LABORER: Roof Tearoff	\$ 11.28**	0.00
LABORER: Landscape and Irrigation	\$ 9.49**	0.00

LATHER	\$ 19.73	0.00
OPERATOR: Backhoe/Excavator/Trackhoe	\$ 14.10**	0.00
OPERATOR: Bobcat/Skid Steer/Skid Loader	\$ 13.93**	0.00
OPERATOR: Bulldozer	\$ 20.77	0.00
OPERATOR: Drill	\$ 16.22	0.34
OPERATOR: Forklift	\$ 15.64**	0.00
OPERATOR: Grader/Blade	\$ 13.37**	0.00
OPERATOR: Loader	\$ 13.55**	0.94
OPERATOR: Mechanic	\$ 17.52	3.33
OPERATOR: Paver (Asphalt, Aggregate, and Concrete)	\$ 16.03**	0.00
OPERATOR: Roller	\$ 16.00**	0.00
PAINTER (Brush, Roller and Spray), Excludes Drywall Finishing/Taping	\$ 16.77	4.51
ROOFER	\$ 15.40**	0.00
SHEET METAL WORKER (HVAC Duct Installation Only)	\$ 17.81	2.64
SHEET METAL WORKER (HVAC Unit Installation Only)	\$ 16.00**	1.61
SPRINKLER FITTER (Fire Sprinklers)	\$ 22.17	9.70
TILE FINISHER	\$ 12.00**	0.00
TILE SETTER	\$ 16.17**	0.00
TRUCK DRIVER: 1/Single Axle Truck	\$ 14.95**	5.23
TRUCK DRIVER: Dump Truck	\$ 12.39**	1.18
TRUCK DRIVER: Flatbed Truck	\$ 19.65	8.57
TRUCK DRIVER: Semi-Trailer Truck	\$ 12.50**	0.00

TRUCK DRIVER: Water Truck	\$ 12.00**	4.11
WATERPROOFER	\$ 14.39**	0.00

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$16.20) or 13658 (\$12.15). Please see the Note at the top of the wage determination for more information.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or "UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division

U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

25.0 PERMITS:

It shall be the sole responsibility of the successful Respondent to obtain any required permits in the name of Fort Bend County.

26.0 TAX EXEMPT:

Fort Bend County is exempt from state and local sales and use taxes under Section 151.309 of the Texas Tax Code. This project will be deemed a separate project for Texas tax purposes, and as such, Fort Bend County hereby issues its Texas Exemption for the purchase of any items qualifying for exemption under this project. Respondent is to issue its Texas Resale Certificate to vendors and subcontractors for such items qualifying for this exemption, and further, Respondent should state these items at cost.

27.0 NAME BRANDS:

Name Brands: Specifications may reference name brands and model numbers. It is not the intent of Fort Bend County to restrict these bids in such cases, but to establish a desired quality level of merchandise or to meet a pre-established standard due to like existing items. Bidders

may offer items of equal stature and the burden of proof of such stature rests with them. Fort Bend County shall act as sole judge in determining equality and acceptability of products offered.

28.0 EVALUATION CRITERIA:

In order to facilitate the analysis of responses to this Proposal, Respondents are required to prepare their proposals in accordance with the instructions outlined in this part. Proposals should be prepared as simply as possible and provide a straightforward, concise description of the Respondent’s capabilities to satisfy the requirements of the Proposal. Emphasis should be concentrated on accuracy, completeness, and clarity of content. All parts, pages, figures, and tables should be numbered and clearly labeled.

28.1 Respondents are required to follow the outline below when preparing their proposals:

Tab	Title
	Title Page
	Letter of Transmittal
	Table of Contents
	Executive Summary
1	Cost
2	Understanding Scope of Work
3	Firm’s Experience
4	Staff Experience
5	Proposed Schedule
6	Overall Completeness of Proposal

28.2 Any exceptions to the Proposal requirements shall be identified in the applicable section.

28.3 Executive Summary - This part of the response to the Proposal should be limited to a brief narrative highlighting the Respondent’s proposal. This section should not include cost quotations. Note that the executive summary should identify the primary contacts for the Respondent.

28.4 Respondents will be evaluated utilizing the factors, as weighted below:

Tab 1	Cost (weight factor = 45%)
	➤ Complete Exhibit I.

Tab 2	Understanding Scope of Work (weight factor = 15%)
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- Respondents must express, in detail, their understanding of this specific project. In addition, describe how the project requested will be provided and managed. Describe the approach your firm will take to the required collaboration, scheduling and coordination required for this project.

Tab 3

Firm's Experience (weight factor = 15%)

- Firm Experience with Projects of Similar Size and Complexity: Such experience must be in the form of providing general contracting services for similar facilities. List a minimum of three (3) similar projects completed within the last ten (10) years; provide the name and location of each project, detailed description of project, completion date, final cost, the client, and a contact person and phone number.

Tab 4

Staff Experience (weight factor = 10%)

- Staff Experience with Projects of Similar Size and Complexity: Such experience must be in the form of providing project management and construction services for similar facilities. List a minimum of three (3) similar projects completed within the last ten (10) years; provide the name and location of each project, the client, and a contact person and phone number and completion date. In addition, provide resumes for project superintendent and project manager who will be assigned to this project.

Tab 5

Proposed Schedule (weight factor = 10%)

- Provide project schedule.

Tab 6

Overall Completeness of Proposal (weight factor = 5%)

- Required Proof of Insurance
- Completed Respondent forms
- Completed W9 form
- Completed debt form
- Completed Contractor Acknowledgement of Stormwater Management Program form

29.0 AWARD:

The County will select the respondent whose proposal is the highest evaluated and responsible for the County. Contractual commitments are contingent upon the availability of funds, as evidenced by the issuance of a purchase order. All contracts are subject to the approval of the County's legal counsel and Commissioners' Court, prior to execution. Once awarded, the contract will be the final expression of the agreement between the parties and may not be altered, changed, or amended except by mutual agreement, in writing.

30.0 RETAINAGE:

Within thirty (30) days after receipt of each uncontested Application for Payment together with the supporting materials required, County shall advance to Contractor the uncontested amount requested in such uncontested Application for Payment, except *five* percent (5%) of the amount requested (hereinafter "Retainage") in each Application for Payment by County. The Retainage withheld shall be released upon final completion of the entire Project and verification of satisfactory work performed, unless grounds exist for withholding payment on account of other defaults by Contractor, including services provided by its sub-contractors.

31.0 LIQUIDATED DAMAGES:

If the Services are not substantially completed within the time for performance or within such additional time as may be extended by County, County will deduct from the final payment as liquidated damages and not as a penalty the sum of two hundred and fifty (\$250.00) per calendar day that the Services are not substantially complete. Such sum is agreed upon as a reasonable and proper measure of the damages County will sustain.

32. STATE LAW REQUIREMENTS FOR CONTRACTS:

The contents of this section are required by Texas Law and are included by County regardless of content.

- 32.1 Agreement to Not Boycott Israel Chapter 2271 Texas Government Code:
Contractor verifies that if Contractor employs ten (10) or more full-time employees and this Agreement has a value of \$100,000 or more, Contractor does not boycott Israel and will not boycott Israel during the term of this Agreement.
- 32.2 Texas Government Code Section 2251.152 Acknowledgment: By signature on vendor form, Contractor represents pursuant to Section 2252.152 of the Texas Government Code, that Contractor is not listed on the website of the Comptroller of the State of Texas concerning the listing of companies that are identified under Section 806.051, Section 807.051 or Section 2253.153.

33.0 HUMAN TRAFFICKING:

By acceptance of this contract, Contractor acknowledges that Fort Bend County is opposed to human trafficking and that no County funds will be used in support of services or activities that violate human trafficking laws.

34.0 REQUIRED FORMS:

All respondents submitting are required to complete the attached and return with submission:

34.1 Vendor Form

34.2 W9 Form

34.3 Tax Form/Debt/Residence Certification

34.4 Contractor Acknowledgement of Stormwater Management Program

35.0 EXHIBIT:

Exhibit I: Pricing

Exhibit II: Project Manual

Exhibit III: Plans

Note. If you are a U.S. person and a requester gives you a form other than Form W-9 to request your TIN, you must use the requester's form if it is substantially similar to this Form W-9.

Definition of a U.S. person. For federal tax purposes, you are considered a U.S. person if you are:

- An individual who is a U.S. citizen or U.S. resident alien;
- A partnership, corporation, company, or association created or organized in the United States or under the laws of the United States;
- An estate (other than a foreign estate); or
- A domestic trust (as defined in Regulations section 301.7701-7).

Special rules for partnerships. Partnerships that conduct a trade or business in the United States are generally required to pay a withholding tax under section 1446 on any foreign partners' share of effectively connected taxable income from such business. Further, in certain cases where a Form W-9 has not been received, the rules under section 1446 require a partnership to presume that a partner is a foreign person, and pay the section 1446 withholding tax. Therefore, if you are a U.S. person that is a partner in a partnership conducting a trade or business in the United States, provide Form W-9 to the partnership to establish your U.S. status and avoid section 1446 withholding on your share of partnership income.

In the cases below, the following person must give Form W-9 to the partnership for purposes of establishing its U.S. status and avoiding withholding on its allocable share of net income from the partnership conducting a trade or business in the United States:

- In the case of a disregarded entity with a U.S. owner, the U.S. owner of the disregarded entity and not the entity;
- In the case of a grantor trust with a U.S. grantor or other U.S. owner, generally, the U.S. grantor or other U.S. owner of the grantor trust and not the trust; and
- In the case of a U.S. trust (other than a grantor trust), the U.S. trust (other than a grantor trust) and not the beneficiaries of the trust.

Foreign person. If you are a foreign person or the U.S. branch of a foreign bank that has elected to be treated as a U.S. person, do not use Form W-9. Instead, use the appropriate Form W-8 or Form 8233 (see Publication 515, Withholding of Tax on Nonresident Aliens and Foreign Entities).

Nonresident alien who becomes a resident alien. Generally, only a nonresident alien individual may use the terms of a tax treaty to reduce or eliminate U.S. tax on certain types of income. However, most tax treaties contain a provision known as a "saving clause." Exceptions specified in the saving clause may permit an exemption from tax to continue for certain types of income even after the payee has otherwise become a U.S. resident alien for tax purposes.

If you are a U.S. resident alien who is relying on an exception contained in the saving clause of a tax treaty to claim an exemption from U.S. tax on certain types of income, you must attach a statement to Form W-9 that specifies the following five items:

1. The treaty country. Generally, this must be the same treaty under which you claimed exemption from tax as a nonresident alien.
2. The treaty article addressing the income.
3. The article number (or location) in the tax treaty that contains the saving clause and its exceptions.
4. The type and amount of income that qualifies for the exemption from tax.
5. Sufficient facts to justify the exemption from tax under the terms of the treaty article.

Example. Article 20 of the U.S.-China income tax treaty allows an exemption from tax for scholarship income received by a Chinese student temporarily present in the United States. Under U.S. law, this student will become a resident alien for tax purposes if his or her stay in the United States exceeds 5 calendar years. However, paragraph 2 of the first Protocol to the U.S.-China treaty (dated April 30, 1984) allows the provisions of Article 20 to continue to apply even after the Chinese student becomes a resident alien of the United States. A Chinese student who qualifies for this exception (under paragraph 2 of the first protocol) and is relying on this exception to claim an exemption from tax on his or her scholarship or fellowship income would attach to Form W-9 a statement that includes the information described above to support that exemption.

If you are a nonresident alien or a foreign entity, give the requester the appropriate completed Form W-8 or Form 8233.

Backup Withholding

What is backup withholding? Persons making certain payments to you must under certain conditions withhold and pay to the IRS 28% of such payments. This is called "backup withholding." Payments that may be subject to backup withholding include interest, tax-exempt interest, dividends, broker and barter exchange transactions, rents, royalties, nonemployee pay, payments made in settlement of payment card and third party network transactions, and certain payments from fishing boat operators. Real estate transactions are not subject to backup withholding.

You will not be subject to backup withholding on payments you receive if you give the requester your correct TIN, make the proper certifications, and report all your taxable interest and dividends on your tax return.

Payments you receive will be subject to backup withholding if:

1. You do not furnish your TIN to the requester,
2. You do not certify your TIN when required (see the Part II instructions on page 3 for details),

3. The IRS tells the requester that you furnished an incorrect TIN,

4. The IRS tells you that you are subject to backup withholding because you did not report all your interest and dividends on your tax return (for reportable interest and dividends only), or

5. You do not certify to the requester that you are not subject to backup withholding under 4 above (for reportable interest and dividend accounts opened after 1983 only).

Certain payees and payments are exempt from backup withholding. See *Exempt payee code* on page 3 and the separate Instructions for the Requester of Form W-9 for more information.

Also see *Special rules for partnerships* above.

What is FATCA reporting?

The Foreign Account Tax Compliance Act (FATCA) requires a participating foreign financial institution to report all United States account holders that are specified United States persons. Certain payees are exempt from FATCA reporting. See *Exemption from FATCA reporting code* on page 3 and the Instructions for the Requester of Form W-9 for more information.

Updating Your Information

You must provide updated information to any person to whom you claimed to be an exempt payee if you are no longer an exempt payee and anticipate receiving reportable payments in the future from this person. For example, you may need to provide updated information if you are a C corporation that elects to be an S corporation, or if you no longer are tax exempt. In addition, you must furnish a new Form W-9 if the name or TIN changes for the account; for example, if the grantor of a grantor trust dies.

Penalties

Failure to furnish TIN. If you fail to furnish your correct TIN to a requester, you are subject to a penalty of \$50 for each such failure unless your failure is due to reasonable cause and not to willful neglect.

Civil penalty for false information with respect to withholding. If you make a false statement with no reasonable basis that results in no backup withholding, you are subject to a \$500 penalty.

Criminal penalty for falsifying information. Willfully falsifying certifications or affirmations may subject you to criminal penalties including fines and/or imprisonment.

Misuse of TINs. If the requester discloses or uses TINs in violation of federal law, the requester may be subject to civil and criminal penalties.

Specific Instructions

Line 1

You must enter one of the following on this line; **do not** leave this line blank. The name should match the name on your tax return.

If this Form W-9 is for a joint account, list first, and then circle, the name of the person or entity whose number you entered in Part I of Form W-9.

a. **Individual.** Generally, enter the name shown on your tax return. If you have changed your last name without informing the Social Security Administration (SSA) of the name change, enter your first name, the last name as shown on your social security card, and your new last name.

Note. ITIN applicant: Enter your individual name as it was entered on your Form W-7 application, line 1a. This should also be the same as the name you entered on the Form 1040/1040A/1040EZ you filed with your application.

b. **Sole proprietor or single-member LLC.** Enter your individual name as shown on your 1040/1040A/1040EZ on line 1. You may enter your business, trade, or "doing business as" (DBA) name on line 2.

c. **Partnership, LLC that is not a single-member LLC, C Corporation, or S Corporation.** Enter the entity's name as shown on the entity's tax return on line 1 and any business, trade, or DBA name on line 2.

d. **Other entities.** Enter your name as shown on required U.S. federal tax documents on line 1. This name should match the name shown on the charter or other legal document creating the entity. You may enter any business, trade, or DBA name on line 2.

e. **Disregarded entity.** For U.S. federal tax purposes, an entity that is disregarded as an entity separate from its owner is treated as a "disregarded entity." See Regulations section 301.7701-2(c)(2)(iii). Enter the owner's name on line 1. The name of the entity entered on line 1 should never be a disregarded entity. The name on line 1 should be the name shown on the income tax return on which the income should be reported. For example, if a foreign LLC that is treated as a disregarded entity for U.S. federal tax purposes has a single owner that is a U.S. person, the U.S. owner's name is required to be provided on line 1. If the direct owner of the entity is also a disregarded entity, enter the first owner that is not disregarded for federal tax purposes. Enter the disregarded entity's name on line 2, "Business name/disregarded entity name." If the owner of the disregarded entity is a foreign person, the owner must complete an appropriate Form W-8 instead of a Form W-9. This is the case even if the foreign person has a U.S. TIN.

Line 2

If you have a business name, trade name, DBA name, or disregarded entity name, you may enter it on line 2.

Line 3

Check the appropriate box in line 3 for the U.S. federal tax classification of the person whose name is entered on line 1. Check only one box in line 3.

Limited Liability Company (LLC). If the name on line 1 is an LLC treated as a partnership for U.S. federal tax purposes, check the "Limited Liability Company" box and enter "P" in the space provided. If the LLC has filed Form 8832 or 2553 to be taxed as a corporation, check the "Limited Liability Company" box and in the space provided enter "C" for C corporation or "S" for S corporation. If it is a single-member LLC that is a disregarded entity, do not check the "Limited Liability Company" box; instead check the first box in line 3 "Individual/sole proprietor or single-member LLC."

Line 4, Exemptions

If you are exempt from backup withholding and/or FATCA reporting, enter in the appropriate space in line 4 any code(s) that may apply to you.

Exempt payee code.

- Generally, individuals (including sole proprietors) are not exempt from backup withholding.
- Except as provided below, corporations are exempt from backup withholding for certain payments, including interest and dividends.
- Corporations are not exempt from backup withholding for payments made in settlement of payment card or third party network transactions.
- Corporations are not exempt from backup withholding with respect to attorneys' fees or gross proceeds paid to attorneys, and corporations that provide medical or health care services are not exempt with respect to payments reportable on Form 1099-MISC.

The following codes identify payees that are exempt from backup withholding. Enter the appropriate code in the space in line 4.

- 1—An organization exempt from tax under section 501(a), any IRA, or a custodial account under section 403(b)(7) if the account satisfies the requirements of section 401(f)(2)
- 2—The United States or any of its agencies or instrumentalities
- 3—A state, the District of Columbia, a U.S. commonwealth or possession, or any of their political subdivisions or instrumentalities
- 4—A foreign government or any of its political subdivisions, agencies, or instrumentalities
- 5—A corporation
- 6—A dealer in securities or commodities required to register in the United States, the District of Columbia, or a U.S. commonwealth or possession
- 7—A futures commission merchant registered with the Commodity Futures Trading Commission
- 8—A real estate investment trust
- 9—An entity registered at all times during the tax year under the Investment Company Act of 1940
- 10—A common trust fund operated by a bank under section 584(a)
- 11—A financial institution
- 12—A middleman known in the investment community as a nominee or custodian
- 13—A trust exempt from tax under section 664 or described in section 4947

The following chart shows types of payments that may be exempt from backup withholding. The chart applies to the exempt payees listed above, 1 through 13.

IF the payment is for . . .	THEN the payment is exempt for . . .
Interest and dividend payments	All exempt payees except for 7
Broker transactions	Exempt payees 1 through 4 and 6 through 11 and all C corporations. S corporations must not enter an exempt payee code because they are exempt only for sales of noncovered securities acquired prior to 2012.
Barter exchange transactions and patronage dividends	Exempt payees 1 through 4
Payments over \$600 required to be reported and direct sales over \$5,000 ¹	Generally, exempt payees 1 through 5 ²
Payments made in settlement of payment card or third party network transactions	Exempt payees 1 through 4

¹ See Form 1099-MISC, Miscellaneous Income, and its instructions.

² However, the following payments made to a corporation and reportable on Form 1099-MISC are not exempt from backup withholding: medical and health care payments, attorneys' fees, gross proceeds paid to an attorney reportable under section 6045(f), and payments for services paid by a federal executive agency.

Exemption from FATCA reporting code. The following codes identify payees that are exempt from reporting under FATCA. These codes apply to persons submitting this form for accounts maintained outside of the United States by certain foreign financial institutions. Therefore, if you are only submitting this form for an account you hold in the United States, you may leave this field blank. Consult with the person requesting this form if you are uncertain if the financial institution is subject to these requirements. A requester may indicate that a code is not required by providing you with a Form W-9 with "Not Applicable" (or any similar indication) written or printed on the line for a FATCA exemption code.

A—An organization exempt from tax under section 501(a) or any individual retirement plan as defined in section 7701(a)(37)

B—The United States or any of its agencies or instrumentalities

C—A state, the District of Columbia, a U.S. commonwealth or possession, or any of their political subdivisions or instrumentalities

D—A corporation the stock of which is regularly traded on one or more established securities markets, as described in Regulations section 1.1472-1(c)(1)(i)

E—A corporation that is a member of the same expanded affiliated group as a corporation described in Regulations section 1.1472-1(c)(1)(i)

F—A dealer in securities, commodities, or derivative financial instruments (including notional principal contracts, futures, forwards, and options) that is registered as such under the laws of the United States or any state

G—A real estate investment trust

H—A regulated investment company as defined in section 851 or an entity registered at all times during the tax year under the Investment Company Act of 1940

I—A common trust fund as defined in section 584(a)

J—A bank as defined in section 581

K—A broker

L—A trust exempt from tax under section 664 or described in section 4947(a)(1)

M—A tax exempt trust under a section 403(b) plan or section 457(g) plan

Note. You may wish to consult with the financial institution requesting this form to determine whether the FATCA code and/or exempt payee code should be completed.

Line 5

Enter your address (number, street, and apartment or suite number). This is where the requester of this Form W-9 will mail your information returns.

Line 6

Enter your city, state, and ZIP code.

Part I. Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. If you are a resident alien and you do not have and are not eligible to get an SSN, your TIN is your IRS individual taxpayer identification number (ITIN). Enter it in the social security number box. If you do not have an ITIN, see *How to get a TIN* below.

If you are a sole proprietor and you have an EIN, you may enter either your SSN or EIN. However, the IRS prefers that you use your SSN.

If you are a single-member LLC that is disregarded as an entity separate from its owner (see *Limited Liability Company (LLC)* on this page), enter the owner's SSN (or EIN, if the owner has one). Do not enter the disregarded entity's EIN. If the LLC is classified as a corporation or partnership, enter the entity's EIN.

Note. See the chart on page 4 for further clarification of name and TIN combinations.

How to get a TIN. If you do not have a TIN, apply for one immediately. To apply for an SSN, get Form SS-5, Application for a Social Security Card, from your local SSA office or get this form online at www.ssa.gov. You may also get this form by calling 1-800-772-1213. Use Form W-7, Application for IRS Individual Taxpayer Identification Number, to apply for an ITIN, or Form SS-4, Application for Employer Identification Number, to apply for an EIN. You can apply for an EIN online by accessing the IRS website at www.irs.gov/businesses and clicking on Employer Identification Number (EIN) under Starting a Business. You can get Forms W-7 and SS-4 from the IRS by visiting IRS.gov or by calling 1-800-TAX-FORM (1-800-829-3676).

If you are asked to complete Form W-9 but do not have a TIN, apply for a TIN and write "Applied For" in the space for the TIN, sign and date the form, and give it to the requester. For interest and dividend payments, and certain payments made with respect to readily tradable instruments, generally you will have 60 days to get a TIN and give it to the requester before you are subject to backup withholding on payments. The 60-day rule does not apply to other types of payments. You will be subject to backup withholding on all such payments until you provide your TIN to the requester.

Note. Entering "Applied For" means that you have already applied for a TIN or that you intend to apply for one soon.

Caution: A disregarded U.S. entity that has a foreign owner must use the appropriate Form W-8.

Part II. Certification

To establish to the withholding agent that you are a U.S. person, or resident alien, sign Form W-9. You may be requested to sign by the withholding agent even if items 1, 4, or 5 below indicate otherwise.

For a joint account, only the person whose TIN is shown in Part I should sign (when required). In the case of a disregarded entity, the person identified on line 1 must sign. Exempt payees, see *Exempt payee code* earlier.

Signature requirements. Complete the certification as indicated in items 1 through 5 below.

1. Interest, dividend, and barter exchange accounts opened before 1984 and broker accounts considered active during 1983. You must give your correct TIN, but you do not have to sign the certification.

2. Interest, dividend, broker, and barter exchange accounts opened after 1983 and broker accounts considered inactive during 1983. You must sign the certification or backup withholding will apply. If you are subject to backup withholding and you are merely providing your correct TIN to the requester, you must cross out item 2 in the certification before signing the form.

3. Real estate transactions. You must sign the certification. You may cross out item 2 of the certification.

4. Other payments. You must give your correct TIN, but you do not have to sign the certification unless you have been notified that you have previously given an incorrect TIN. "Other payments" include payments made in the course of the requester's trade or business for rents, royalties, goods (other than bills for merchandise), medical and health care services (including payments to corporations), payments to a nonemployee for services, payments made in settlement of payment card and third party network transactions, payments to certain fishing boat crew members and fishermen, and gross proceeds paid to attorneys (including payments to corporations).

5. Mortgage interest paid by you, acquisition or abandonment of secured property, cancellation of debt, qualified tuition program payments (under section 529), IRA, Coverdell ESA, Archer MSA or HSA contributions or distributions, and pension distributions. You must give your correct TIN, but you do not have to sign the certification.

What Name and Number To Give the Requester

For this type of account:	Give name and SSN of:
1. Individual	The individual
2. Two or more individuals (joint account)	The actual owner of the account or, if combined funds, the first individual on the account ¹
3. Custodian account of a minor (Uniform Gift to Minors Act)	The minor ²
4. a. The usual revocable savings trust (grantor is also trustee) b. So-called trust account that is not a legal or valid trust under state law	The grantor-trustee ¹ The actual owner ¹
5. Sole proprietorship or disregarded entity owned by an individual	The owner ³
6. Grantor trust filing under Optional Form 1099 Filing Method 1 (see Regulations section 1.671-4(b)(2)(i)(A))	The grantor*
For this type of account:	Give name and EIN of:
7. Disregarded entity not owned by an individual	The owner
8. A valid trust, estate, or pension trust	Legal entity ⁴
9. Corporation or LLC electing corporate status on Form 8832 or Form 2553	The corporation
10. Association, club, religious, charitable, educational, or other tax-exempt organization	The organization
11. Partnership or multi-member LLC	The partnership
12. A broker or registered nominee	The broker or nominee
13. Account with the Department of Agriculture in the name of a public entity (such as a state or local government, school district, or prison) that receives agricultural program payments	The public entity
14. Grantor trust filing under the Form 1041 Filing Method or the Optional Form 1099 Filing Method 2 (see Regulations section 1.671-4(b)(2)(i)(B))	The trust

¹ List first and circle the name of the person whose number you furnish. If only one person on a joint account has an SSN, that person's number must be furnished.

² Circle the minor's name and furnish the minor's SSN.

³ You must show your individual name and you may also enter your business or DBA name on the "Business name/disregarded entity" name line. You may use either your SSN or EIN (if you have one), but the IRS encourages you to use your SSN.

⁴ List first and circle the name of the trust, estate, or pension trust. (Do not furnish the TIN of the personal representative or trustee unless the legal entity itself is not designated in the account title.) Also see *Special rules for partnerships* on page 2.

*Note. Grantor also must provide a Form W-9 to trustee of trust.

Note. If no name is circled when more than one name is listed, the number will be considered to be that of the first name listed.

Secure Your Tax Records from Identity Theft

Identity theft occurs when someone uses your personal information such as your name, SSN, or other identifying information, without your permission, to commit fraud or other crimes. An identity thief may use your SSN to get a job or may file a tax return using your SSN to receive a refund.

To reduce your risk:

- Protect your SSN,
- Ensure your employer is protecting your SSN, and
- Be careful when choosing a tax preparer.

If your tax records are affected by identity theft and you receive a notice from the IRS, respond right away to the name and phone number printed on the IRS notice or letter.

If your tax records are not currently affected by identity theft but you think you are at risk due to a lost or stolen purse or wallet, questionable credit card activity or credit report, contact the IRS Identity Theft Hotline at 1-800-908-4490 or submit Form 14039.

For more information, see Publication 4535, Identity Theft Prevention and Victim Assistance.

Victims of identity theft who are experiencing economic harm or a system problem, or are seeking help in resolving tax problems that have not been resolved through normal channels, may be eligible for Taxpayer Advocate Service (TAS) assistance. You can reach TAS by calling the TAS toll-free case intake line at 1-877-777-4778 or TTY/TDD 1-800-829-4059.

Protect yourself from suspicious emails or phishing schemes. Phishing is the creation and use of email and websites designed to mimic legitimate business emails and websites. The most common act is sending an email to a user falsely claiming to be an established legitimate enterprise in an attempt to scam the user into surrendering private information that will be used for identity theft.

The IRS does not initiate contacts with taxpayers via emails. Also, the IRS does not request personal detailed information through email or ask taxpayers for the PIN numbers, passwords, or similar secret access information for their credit card, bank, or other financial accounts.

If you receive an unsolicited email claiming to be from the IRS, forward this message to phishing@irs.gov. You may also report misuse of the IRS name, logo, or other IRS property to the Treasury Inspector General for Tax Administration (TIGTA) at 1-800-366-4484. You can forward suspicious emails to the Federal Trade Commission at: spam@uce.gov or contact them at www.ftc.gov/idtheft or 1-877-IDTHEFT (1-877-438-4338).

Visit IRS.gov to learn more about identity theft and how to reduce your risk.

Privacy Act Notice

Section 6109 of the Internal Revenue Code requires you to provide your correct TIN to persons (including federal agencies) who are required to file information returns with the IRS to report interest, dividends, or certain other income paid to you; mortgage interest you paid; the acquisition or abandonment of secured property; the cancellation of debt; or contributions you made to an IRA, Archer MSA, or HSA. The person collecting this form uses the information on the form to file information returns with the IRS, reporting the above information. Routine uses of this information include giving it to the Department of Justice for civil and criminal litigation and to cities, states, the District of Columbia, and U.S. commonwealths and possessions for use in administering their laws. The information also may be disclosed to other countries under a treaty, to federal and state agencies to enforce civil and criminal laws, or to federal law enforcement and intelligence agencies to combat terrorism. You must provide your TIN whether or not you are required to file a tax return. Under section 3406, payers must generally withhold a percentage of taxable interest, dividend, and certain other payments to a payee who does not give a TIN to the payer. Certain penalties may also apply for providing false or fraudulent information.

Mandatory Form



Contractor Acknowledgement of Storm Water Management Program

I hereby acknowledge that I am aware of the stormwater management program and standard operating procedures developed by Fort Bend County in compliance with the TPDES General Permit No. TXR040000. I agree to comply with all applicable best management practices and standard operating procedures while conducting my services for Fort Bend County. I agree to conduct all services in a manner that does not introduce illicit discharges of pollutants to streets, stormwater inlets, drainage ditches or any portion of the drainage system. The following materials and/or pollutant sources must not be discharged to the drainage system as a result of any services provided:

1. Grass clippings, leaves, mulch, rocks, sand, dirt or other waste materials resulting from landscaping activities, (except those materials resulting from ditch mowing or maintenance activities)
2. Herbicides, pesticides and/or fertilizers, (except those intended for aquatic use)
3. Detergents, fuels, solvents, oils and/or lubricants, other equipment and/or vehicle fluids,
4. Other hazardous materials including paints, thinners, chemicals or related waste materials,
5. Uncontrolled dewatering discharges, equipment and/or vehicle wash waters,
6. Sanitary waste, trash, debris, or other waste products
7. Wastewater from wet saw machinery,
8. Other pollutants that degrade water quality or pose a threat to human health or the environment.

Furthermore, I agree to notify Fort Bend County immediately of any issue caused by or identified by:

(Company/Contractor)

that is believed to be an immediate threat to human health or the environment.

Contractor Signature

Date

Printed Name

Title

RFP 23-026

Exhibit I: Pricing

Total Bid

\$ _____

Calendar days for completion _____

Acknowledgement of Receipt of Addendum(s), if issued by Purchasing, to the Request for Proposal Document.

Addendum No 1 dated _____ Received _____

Addendum No 2 dated _____ Received _____

Addendum No 3 dated _____ Received _____

Name of Respondent

Signature of Authorized Representative

Printed Name of Representative



Project Manual

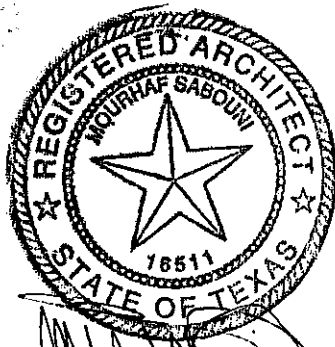
General Documents, Divisions 00, 01 - 49

ISSUED FOR BID, PERMIT, AND CONSTRUCTION

12-13-2022

Project Scope:

FORT BEND COUNTY, PRECINCT 3 ANNEX
Sugar Land, Texas

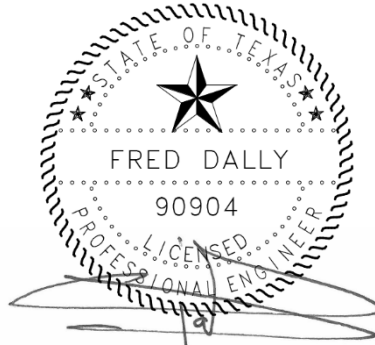


Mourhaf Sabouni
12/13/2022

12/13/2022



M. W. Mirza



12-13-2022



12-13-22



Sevak Kalantarians

Sevak Kalantarians



Isa Tan

Project Manual

General Documents, Divisions 00, 01 - 49

ISSUED FOR BID, PERMIT, AND CONSTRUCTION

12-13-2022

Project Scope:

FORT BEND COUNTY, PRECINCT 3 ANNEX

Sugar Land, Texas

00 31 32

GEOTECHNICAL DATA

1.1 SUMMARY

- A. This document includes information pertaining to geotechnical data.

1.2 INVESTIGATION

- A. An investigation of subsurface soil conditions at the building site was performed by Raba Kistner on November 24, 2021, Project No. AHA21-067-00.

1.3 REPORT

- A. The Geotechnical Investigation Report bound herein is for Bidder's convenience and information only and is not a warranty of subsurface conditions.
- B. The complete text of the Report may also be examined by qualified Bidders at the office of the Architect and where documents are on file for bidding purposes.
- C. The Report is made available for Bidder's information only and is bound as part of the Contract Document.
- D. The information contained in the Report represents design criteria, recommendations, and guidelines that were utilized as the basis of design for the engineering of the earthwork operations, paving design, and foundation design indicated in the Contract Documents. No changes in these design criteria will be considered or permitted.

1.4 RESPONSIBILITY

- A. Bidders are expected to examine the site and subsurface investigation reports and then decide for themselves the character of the materials to be encountered.
- B. The Architect and Owner assume no responsibility for variations in subsoil conditions, quality, or stability, or for the presence, level, and extent of underground water.
- C. The Architect and Owner assume no responsibility for Bidder's interpretation of data contained in the Report.

END OF DOCUMENT



GEOTECHNICAL ENGINEERING STUDY

FOR

**4.97-ACRE TRACT
SUGAR LAND, TEXAS**

Project No. AHA21-067-00
November 24, 2021

3602 Westchase
Houston, TX 77042

P 713.996.8990
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TBPE Firm F-3257

WWW.RKCI.COM

Mr. James Knight, Architect
Director of Facilities
Fort Bend County
301 Jackson Street, Suite 301
Richmond, TX 77469

**RE: Geotechnical Engineering Study – Revision No. 1
4.97-Acre Tract
NW Corner of the Intersection of Imperial Boulevard and Stadium Drive
Sugar Land, Texas**

Dear Mr. Knight:

RABA KISTNER Consultants, Inc. (RKCI) is pleased to submit the report of our Geotechnical Engineering Study for the above-referenced project. This study was performed in accordance with the **RKCI** Proposal No. PHA21-119-01, dated November 8, 2021. The purpose of this study was to drill borings within the proposed office building, to perform laboratory testing on selected soil samples to classify and characterize subsurface conditions, and to prepare an engineering report presenting preliminary foundation design and construction recommendations for the proposed building, as well as to provide pavement design and construction guidelines.

The following report contains our design recommendations and considerations based on our current understanding of the finished floor elevation, design tolerances, and structural and pavement loads. If any of these parameters change, there may be alternatives for value engineering of the foundation and pavement systems, and **RKCI** recommends that a meeting be held with Fort Bend County (CLIENT) and the design team to evaluate these alternatives.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance on the materials testing-quality control program during construction, please call.

Very truly yours,
RABA KISTNER CONSULTANTS, INC.



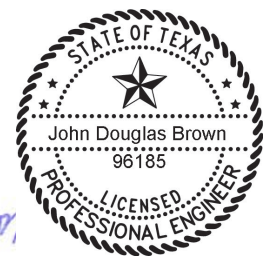
Jasmine Vereen
Graduate Engineer

JV/JDB/hc
Attachments

Copies Submitted: Above (1-Electronic)



John D. Brown, P.E.
Manager, Geotechnical Services



11-24-2021

GEOTECHNICAL ENGINEERING STUDY

For

**4.97-ACRE TRACT
SUGAR LAND, TEXAS**

Prepared for

FORT BEND COUNTY
Richmond, Texas

Prepared by

RABA KISTNER CONSULTANTS, INC.
Houston, Texas

PROJECT NO. AHA21-067-00

November 24, 2021

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- Boring Location Map
- Logs of Borings
- Key to Terms and Symbols
- Results of Soil Sample Analyses
- Important Information About Your Geotechnical Engineering Report

INTRODUCTION

RABA KISTNER Consultants, Inc. (RKCI) has completed the authorized subsurface exploration and preliminary foundation and pavement recommendations for the proposed office building to be located at intersection Imperial Boulevard and Stadium Drive in Sugar Land, Texas. This report briefly describes the procedures utilized during this study and presents our findings along with our recommendations for foundation and pavement design and construction considerations.

PROJECT DESCRIPTION

We understand that the CLIENT is conducting a feasibility study for a two-story office building totaling approximately 4.97-acres and as part of such study a preliminary geotechnical study is required. The two-story office building is situated on the northwest corner of the intersection of Imperial Boulevard and Stadium Drive in Sugar Land, Texas. A re-mobilized drill rig will be located at the site to drill a 40-ft deep additional boring.

The proposed building structure is expected to create relatively light to moderate loads to be carried by the foundation systems, which are anticipated to consist of a shallow or deep foundation system such as isolated spread footings or drilled-and-underreamed piers. Floor systems consisting of slabs-on-ground or slabs-on-fill are expected to be preferred, provided soil-related, potential vertical movements will not cause structural performance problems. The pavement systems are anticipated to consist of a combination of both flexible (asphalt) and/or rigid (concrete) pavements.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the Houston area by Geotechnical firms conducting similar work under similar circumstances and is meant for the use of CLIENT and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses and is not intended for use in determining construction means and methods.

The recommendations submitted in this report are based on the data obtained from four borings drilled at this site and our understanding of the project information provided to us by others. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report. **RKCI's** scope of work does not include the investigation, detection, or design

related to the prevention of any biological pollutants. The term “biological pollutants” includes, but is not limited to, mold, fungi, spores, bacteria, and viruses, and the byproduct of any such biological organisms.

If final grade elevations are significantly different from those provided to us by others by more than plus or minus 1-ft, our office should be informed about these changes. If needed and/or if desired, we will reexamine our analyses and make supplemental recommendations.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by 4 borings (designated as B-1 through B-4) drilled at the locations shown on the Boring Location Map, Figure 1. The boring locations are approximate and were spaced evenly throughout the approximately 4.97-acre tract by an **RKCI** representative, and by measuring distances from existing references. Latitude-longitude at the boring locations was estimated using Google Earth. The coordinates are shown on the boring logs.

The borings were drilled to a depths of 20-ft to 40-ft below the ground surface elevation existing at the time of our study using a buggy-mounted drilling rig. The borings were drilled utilizing solid flight auger drilling techniques and were backfilled with the auger cuttings generated during the drilling activities. During drilling operations, the following samples were collected:

Type of Sample	Number Collected
Undisturbed Shelby Tube (ST)	6
Standard Penetration Test (SPT) Split Spoon	30
Grab Sample (Auger Cutting)	5

The ST and SPT samples were obtained in general accordance with accepted standard practices. The SPT results are noted as “blows per foot” on the boring logs. The term “blows per foot” refers to the number of blows by a 30-inch free falling 140-lb hammer required for 12-inches of penetration into the subsurface materials. Grab samples were collected from the flight auger during drilling. Representative portions of the samples were sealed in containers to reduce moisture loss, labeled, packaged, and transported to our laboratory for subsequent testing and classification.

In the laboratory, each sample was evaluated and visually classified by a member of our Geotechnical Engineering staff in general accordance with the Unified Soil Classification System (USCS). The geotechnical engineering properties of the strata were evaluated by the laboratory tests tabulated in the following table.

Type of Test	Number Conducted
Natural Moisture Content	32
Atterberg Limits	9
Percent Passing a No. 200 Sieve	10
Unconfined Compression	4

The laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures 2 through 5. A key to the classification of terms and symbols used on the logs is presented on Figure 6. The results of the laboratory and field testing are also tabulated on Figure 7 for ease of reference.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the CLIENT.

GENERAL SITE CONDITIONS

SITE DESCRIPTION

The project site consists of a land tract totaling approximately 4.97 acres. The site is currently an undeveloped and relatively flat grass field.

GEOLOGY

The Bureau of Economic Geology, Geologic Atlas of Texas, Sequin Sheet shows the subject site to be underlain by Alluvium, which are floodplain deposits and can include clays, sands, silts, and gravels. The formation includes point-bar, natural levee, stream channel, backswamp, coastal marsh, mud-flat, and narrow beach deposits. Fossils are rare and modern. The lower contact is unconformable and the thickness is variable. Such deposits are typically highly variable and can therefore result in highly variable conditions over relatively short distances.

SEISMIC COEFFICIENTS

On the basis of the soil borings conducted for this investigation, the upper 100 feet of soil may be characterized as stiff soil and a **Class D** Site Class Definition (Chapter 20 of ASCE 7) has been assigned to this site.

On the basis of the Structural Engineers Associated of California (SEAoC) website¹ which utilizes the International Building Code (IBC) and U.S. Seismic Design Maps to develop seismic design parameters, the following seismic considerations are associated with this site.

- **$S_s = 0.065g$**
- **$S_1 = 0.037g$**
- **$S_{ms} = 0.105g$**
- **$S_{m1} = 0.09g$**
- **$S_{DS} = 0.07g$**
- **$S_{D1} = 0.06g$**

Based on the parameters listed above as well as Tables 1613.3.5(1) and 1613.3.5(2) of the 2012 IBC, the Seismic Design Category for both short period and 1 second response accelerations is **A**. As part of the assumptions required to complete the calculations, a Risk Category of "I or II or III" was selected.

¹ <http://seismicmaps.org>

STRATIGRAPHY

The subsurface conditions encountered at the boring locations are shown on the boring logs, Figures 2 through 5. The boring logs should be consulted for boring specific (detailed) stratigraphic information. These boring logs represent our interpretation of the subsurface conditions based on the field logs, visual examination of field samples by our personnel, and laboratory test results of selected field samples. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual.

The subsurface stratigraphy at this site consists of a 4-ft to 6-ft deep mantle of cohesive, plastic to highly plastic, firm to very stiff consistency, lean clay (CL), sandy fat clay (CH), and fat clay (CH), underlain by very soft to soft consistency, low to moderate plasticity, semi-cohesive silty clay (CL-ML) and sandy silty clay (CL-ML), cohesive lean clay (CL), and cohesionless sandy silty (ML), and poorly graded sand with silt (SP-SM). Roots were observed within the upper 4-ft to 6-ft deep cohesive soils. Measured moisture contents range from 18 to 31. Based on grain size analyses, the percentage of fines (percent passing a No. 200 sieve) within this stratum ranges from 87 to 98 percent. Plasticity index (PI) values vary from 10 to 48. Based on the unconfined compression tests performed on selected cohesive samples recovered from the 2-ft to 4-ft depth range in the project borings, undrained shear strength values range from 0.34 to 1.19 tsf. The tested samples measured dry unit weights of 95 pcf to 112 pcf. SPT N-values registered within the cohesive clays range from 2 to 6 blows per foot, indicative of very soft to firm, but mostly soft consistencies.

Semi-cohesive sandy silty clay (CL-ML), silty clay (CL-ML), and cohesionless sandy silt (ML), and poorly graded sand with silt (SP-SM) layers were observed in Borings B-1, B-2, and B-4. These soils recorded moisture contents ranging from 22 to 37 percent. Plasticity index (PI) values range from 1 to 7 percent. Based on grain size analyses, the percentage of fines (percent passing a No. 200 sieve) ranges from 8 to 85 percent. SPT N-values registered within the semi-cohesive/cohesionless sands range from 2 to 21 blows per foot.

GROUNDWATER

Groundwater was encountered in the project borings during drilling. Groundwater level measurements are listed in the following table:

Groundwater Depth Measurements

Boring No.	Depth Encountered (feet)	Water Depth After 15 Minutes (feet)
B-1	10.0	8.7
B-2	9.0	8.5
B-3	9.4	7.7
B-4	10.0	8.0

It is possible for groundwater to exist beneath this site at shallow depths on a transient basis, particularly in interbedded sand seams following periods of precipitation. Fluctuations in groundwater levels are possible due to variations in rainfall and surface water run-off. The construction process itself may also cause variations in the groundwater levels.

Based on the findings in our borings and on our experience in this region, we believe that groundwater seepage encountered during site earthwork activities and foundation construction may be controlled using temporary earthen berm and conventional sump-and-pump dewatering methods.

PRELIMINARY FOUNDATION ANALYSIS

EXPANSIVE SOIL-RELATED MOVEMENTS

The anticipated ground movements due to swelling of the underlying soils at the site were estimated for slab-on-grade construction using the empirical procedure, Texas Department of Transportation (TxDOT) Tex-124-E, Method for Determining the Potential Vertical Rise (PVR). A PVR value of about 2 ¾ -inches was estimated for the stratigraphic conditions encountered in our borings. A surcharge load of 1.0 psi (6-inch concrete slab and sand cushion), an active zone of 6-ft, and average to dry moisture conditions were assumed in estimating the above PVR values.

The TxDOT method of estimating expansive soil-related movements is based on empirical correlations utilizing the measured plasticity indices and assuming typical seasonal fluctuations in moisture content. If desired, other methods of estimating expansive, soil-related movements are available, such as estimations based on swell tests and/or soil-suction analyses. However, the performance of these tests and the detailed analysis of expansive soil-related movements were beyond the scope of the current study. It should also be noted that actual movements can exceed the estimated PVR values due to isolated changes in moisture content (such as due to leaks, landscape watering...) or if water seeps into the soils to greater depths than the assumed active zone depth due to deep trenching or excavations.

OVEREXCAVATION AND SELECT FILL REPLACEMENT

To reduce expansive, soil-related movements in at-grade construction, a portion of the upper expansive subgrade clays within the building area can be removed by overexcavating and backfilling with a suitable select fill material. PVR value has been estimated for overexcavation and select fill replacement to various depths below the ground surface elevation existing at the time of our study and are summarized in the table below. Recommendations for the selection and placement of select backfill materials are addressed in a subsequent section of this report.

Depth of Overexcavation and Select Fill Replacement (ft)*	Estimated PVR (in.)
0	2 ¾
2	1 ¾
3.5	<1

*below the ground surface elevation existing at the time of our study.

The building's finished floor elevation (FFE) is unknown and was assumed to be 1-ft above the existing ground surface elevation. Therefore, the depth of clay to undercut to reduce the estimated PVR value to 1-inch would be about 3-ft, assuming 6-inches of select fill plus a 5-inch thick concrete slab and 1-inch thick sand cushion. The select fill pad should extend at least 5 feet beyond the building perimeter.

DRAINAGE CONSIDERATIONS

Water entering the fill surface during construction or entering the fill exposed beyond the building lines after construction may create problems with fill moisture control during compaction.

Several surface and subsurface drainage design features and construction precautions can be used to limit problems associated with fill moisture. These features and precautions may include but are not limited to the following:

- Installing berms or swales on the uphill side of the construction area to divert surface runoff away from the excavation/fill area during construction;
- Sloping of the top of the subgrade with a minimum downward slope of 1.5 percent out to the base of a dewatering trench located beyond the building perimeter;
- Sloping the surface of the fill during construction to promote runoff of rain water to drainage features until the final lift is placed;
- Sloping of a final, well maintained, impervious clay or pavement surface (downward away from the building) over the select fill material and any perimeter drain extending beyond the building lines, with a minimum gradient of 6-in. in 5-ft;
- Constructing final surface drainage patterns to prevent ponding and limit surface water infiltration at and around the building perimeter;
- Locating the water-bearing utilities, roof drainage outlets and irrigation spray heads outside of the select fill and perimeter drain boundaries; and
- Raising the elevation of the ground level floor slab.

Details relative to the extent and implementation of these considerations must be evaluated on a project-specific basis by all members of the project design team. Many variables that influence fill drainage considerations may depend on factors that are not fully developed in the early stages of design. For this reason, drainage of the fill should be given consideration at the earliest possible stages of the project.

PRELIMINARY FOUNDATION RECOMMENDATIONS

FOUNDATION CONSIDERATIONS

Review of the borings and test data indicate that the factors discussed below will affect foundation design and construction at this site.

- A stiff to very stiff, 4-ft to 6-ft deep cohesive clay crust, underlain by soft to very soft, cohesive/semi-cohesive clays.

- The surficial low plastic clayey sands, silty clayey sands, sandy silt, and poorly graded sand with silt are moisture-sensitive and will become weak and soft when saturated. These conditions could result in construction delays.

We recommend that the proposed building structure be supported on spread footings bearing on properly prepared select fill. Alternatively, the building could be supported on deep foundations such as drilled straight-sided piers. The floor slab can be supported on a select fill pad having the necessary thickness to reduce PVR to 1-inch or less.

SITE GRADING

Site grading plans can result in changes in almost all aspects of foundation recommendations. We have prepared the foundation recommendations based on the existing and proposed finished floor elevations discussed throughout this report. If site grading plans differ from those discussed in this report by more than plus or minus 1-ft, **RKCI** must be retained to review the site grading plans prior to bidding the project for construction. This will enable us to provide input for any changes in our original recommendations, which may be required as a result of site grading operations or other considerations.

DRILLED STRAIGHT-SIDED PIERS

Allowable axial capacities for 18, 24, 30, and 36-inch diameter drilled shafts were computed using the static method of analysis and are presented on Figure 8. End bearing was neglected in our analysis. The soil stratigraphy and parameters included in our axial capacity calculations are presented below.

Soil Stratigraphy and Parameters

Stratum	Top Depth, ft	Bottom Depth, ft	Soil Type	Buoyant Unit Weight, pcf	Internal Friction Angle, degrees	Undrained Shear Strength, psf
I	0	5	(Ignore)	124	--	1000
II	5	6	Cohesive	124	--	800
III	6	8	Cohesionless	115	28	--
IV	8	33	Cohesionless	52	28	--
V	33	40	Cohesionless	57	34	--

We recommend discounting the frictional resistance of the soils in the upper 5-ft depth to account for possible disturbance during construction and possible shrinkage of the cohesive soils with variations in moisture.

Presented below are our recommended factors of safety for different loading conditions. These recommended factors were applied to the ultimate axial capacity to obtain the allowable axial capacity values see Figure 8.

Drilled Shaft Axial Capacity Safety Factors

Compression-Side Shear	Tension	End Bearing
2.0	2.0	3.0

An increase in the uplift capacity of drilled shafts can be achieved by adding the weight of the foundation to the axial capacities presented in this report. A buoyant unit weight of 90 pcf should be applied to the shaft/pile concrete. We recommend a factor of safety of 1.2 be applied to the shaft/pile weight.

Lateral Resistance

Resistance to lateral loads and the expected shaft behavior under the applied loading conditions will depend not only on subsurface conditions, but also on loading conditions, the pier size, and the engineering properties of the pile. As this information is not yet available, analysis of pile behavior is not possible at this time. Once structural loading is known, and preliminary pile sizes, concrete strength, and reinforcement is known, the piles should be analyzed to determine the resulting lateral deflection, maximum bending moment, ultimate bending moment, and whether a point of fixity develops. This type of analysis is typically performed utilizing a computer analysis program and usually requires a trial and error procedure to appropriately size the piers and meet project tolerances.

To assist the design engineer in this procedure, we are providing the following soil parameters for use in analysis. These parameters are in accordance with the input requirements of one of the more commonly used computer programs for laterally loaded piles, the “L-Pile” program. If a different program is used for analysis, different parameters may be required and different limitations may be required than what was assumed in selecting the parameters given below. Thus, if a program other than “L-Pile” is used, R-K must be notified of the analysis method, so that we can review and revise our recommendations if required.

The soil-related parameters required for input into the “L-Pile” are summarized below.

Soil Parameters for L-Pile Input

Layer	Assumed Behavior for Analysis	Depth (ft)	c (psf)	ϕ (°)	ϵ_{50}	k_s (pci)	γ (pcf)
I	Model as Free Column	0-5	--	--	--	--	124
II	Stiff Clay w/o Free Water	5-6	800		0.01	100	124
III	Sand (Reese et al., 1974)	6-8	--	28	--	25	115
IV	Sand (Reese et al., 1974)	8-33	--	28	--	20	52
V	Sand (Reese et al., 1974)	33-40	--	34	--	60	57

Where:

- k_s = horizontal modulus of subgrade reaction (static)
- ϵ_{50} = strain at 50 percent

γ = buoyant unit weight
c = undrained shear strength
 ϕ = angle of internal friction

Soil resistance and pier deflection values (p-y curves) for the upper 5-ft should be modified to include a very small p value. Zeroing the soil parameters for that depth interval would interfere with effective stress calculations at lower depths. The values presented above for subgrade modulus and the strain at 50% are based on recommended values for the L-Pile program for the strength of materials encountered in our borings and are not necessarily based on laboratory test results.

The parameters presented in the above table do **not** include factors of safety. We recommend that a factor of safety of at least 2 be introduced to the analysis by doubling the applied lateral loads and moments.

GRADE BEAMS

Grade beams interconnecting the piers may bear on undisturbed native soils or select fill and should be sized to support the design loads. Grade beams should have a minimum width of 12-inches and a maximum allowable bearing pressure of 1,800 psf. The grade beams may be earth-formed.

FLOOR SLABS

We recommend that a vapor barrier comprised of polyethylene or polyvinylchloride (PCV) sheeting be placed between the supporting soils and the concrete floor slab. Vapor barrier / retarder shall meet the specifications for durability and permeance set forth in ASTM E1745.

FOUNDATION CONSTRUCTION CONSIDERATIONS

SITE DRAINAGE

Drainage is an important key to the successful performance of any foundation. Good surface drainage should be established prior to and maintained after construction to help prevent water from ponding within or adjacent to the building foundation and to facilitate rapid drainage away from the building foundation. Failure to provide positive drainage away from the structures can result in localized differential vertical movements in soil supported foundations and floor slabs (which can in turn result in cracking in the sheetrock partition walls and shifting of ceiling tiles, as well as improper operation of windows and doors).

Current ordinances, in compliance with the Americans with Disabilities Act (ADA), may dictate maximum slopes for walks and drives around and into new buildings. These slope requirements can result in drainage problems for buildings supported on expansive soils. We recommend that, on all sides of the buildings, the maximum permissible slope is provided away from the buildings.

Also to help control drainage in the vicinity of the structures, we recommend that roof/gutter downspouts and landscaping irrigation systems not be located adjacent to the building foundation. Where a select fill overbuild is provided outside of the floor slab/foundation footprint, the surface should be sealed with an

impermeable layer (pavement or clay cap) to reduce infiltration of both irrigation and surface waters. Careful consideration should also be given to the location of water bearing utilities, as well as to provisions for drainage in the event of leaks in water bearing utilities. All leaks should be immediately repaired.

Other drainage and subsurface drainage issues are discussed in the *Pavement Construction Considerations* section of this report.

SITE PREPARATION

Building areas and all areas to support select fill should be stripped of all vegetation, topsoil, roots, and other deleterious materials. After stripping and grubbing, the exposed subgrade should be thoroughly proofrolled in order to locate and densify any weak, compressible zones. A minimum of 5 passes of a fully-loaded dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or his representative to document subgrade condition and preparation. Weak or soft areas identified during proofrolling should be removed and replaced with suitable, compacted on-site clays, free of organics, oversized materials, and degradable or deleterious materials.

Upon completion of the proofrolling operations and just prior to fill placement or slab construction, the exposed subgrade should be moisture conditioned by scarifying to a minimum depth of 6 in. and recompacting to a minimum of 95 percent of the maximum dry density as determined by American Society of Testing and Materials (ASTM) D698. The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum moisture content until permanently covered.

SELECT FILL

Materials used as select fill for final site grading preferably should be inert cohesive/semi-cohesive sandy lean clays (CL)/clayey sands (SC) as classified according to the USCS, may be considered satisfactory for use as select fill materials at this site. Select fill materials shall have a maximum liquid limit not exceeding 40 percent, a plasticity index between 7 and 20 percent, and a maximum particle size not exceeding 4 in. or one-half the loose lift thickness, whichever is smaller. In addition, if these materials are utilized, grain size analyses and Atterberg Limits must be performed during placement at a minimum rate of one test each per 5,000 cubic yards of material due to the high degree of variability associated with pit-run materials.

If the above listed materials are being considered for bidding purposes, the materials should be submitted to the Geotechnical Engineer for pre-approval at a minimum of 10 working days or more prior to the bid date. Failure to do so will be the responsibility of the contractor. The contractor will also be responsible for ensuring that the properties of all delivered alternate select fill materials are similar to those of the pre-approved submittal.

Soils classified as CH, MH, ML, SM, GM, OH, OL and Pt under the USCS are **not** considered suitable for use as select fill materials. The soils encountered in the project borings are generally **not** considered suitable for use as select fill materials.

Select fill should be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of maximum density as determined by ASTM D 698. The moisture content of the fill should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction.

SHALLOW FOUNDATION EXCAVATIONS

Shallow foundation excavations should be observed by the Geotechnical Engineer or his representative prior to placement of reinforcing steel and concrete. This is necessary to document that the bearing soils at the bottom of the excavations are similar to those encountered in the borings and that excessive soft/loose materials and water are not present in the excavations. If soft/loose pockets of soil are encountered in the foundation excavations, they should be removed and replaced with a compacted non-expansive fill material or lean concrete up to the design foundation bearing elevations.

Disturbance from foot traffic and from the accumulation of excess water can result in losses in bearing capacity and increased settlement. If inclement weather is anticipated at the time construction, consideration should be given to protecting the bottoms of beam trenches by placing a thin mud mat (layer of flowable fill or lean concrete) at the bottom of trenches immediately following excavation. This will reduce disturbance from foot traffic and will impede the infiltration of surface water. All necessary precautions should be implemented to protect open excavations from the accumulation of surface water runoff and rain.

EXCAVATION SLOPING AND BENCHING

If utility trenches or other excavations extend to or below a depth of 5-ft below construction grade, the contractor or others shall be required to develop a trench safety plan to protect personnel entering the trench or trench vicinity. The collection of specific geotechnical data and the development of such a plan, which could include designs for sloping and benching or various types of temporary shoring, are beyond the scope of the current study. Any such designs and safety plans shall be developed in accordance with current Occupational Safety and Health Administration (OSHA) trench safety guidelines (29 CFR 1926 Subpart P Appendix A) and other applicable industry standards.

EXCAVATION EQUIPMENT

Our boring logs are not intended for use in determining construction means and methods and may therefore be misleading if used for that purpose. We recommend that earth-work and utility contractors interested in bidding on the work perform their own tests in the form of test pits or test piers to determine the quantities of the different materials to be excavated, as well as the preferred excavation methods and equipment for this site.

UTILITIES

Utilities which project through slab-on-grade, slab-on-fill, or any other rigid unit should be designed with either some degree of flexibility or with sleeves. Such design features will help reduce the risk of damage

to the utility lines as vertical movements occur. These types of slabs will generally be constructed as monolithic, grid-type beam and slab foundations.

Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials. The potential for water to access the backfill is increased where water can infiltrate flexible base materials due to insufficient penetration of curbs, and at sites where geological features can influence water migration into utility trenches.

To reduce the potential for settlement in utility trenches, we recommend that consideration be given to the following:

- All backfill materials should be placed and compacted in controlled lifts appropriate for the type of backfill and the type of compaction equipment being utilized and all backfilling procedures should be tested and documented.
- Curbs should completely penetrate flexible base materials and be installed to a sufficient depth to reduce water infiltration beneath the curbs into the pavement base materials.

AREA FLATWORK

It should be noted that ground-supported flatwork such as walkways, driveways, courtyards, sidewalks, etc., will be subject to the same magnitude of potential soil-related movements as discussed previously (see *Expansive Soil-Related Movements* subsection of the *Foundation Analysis* section of this report) for this site. Thus, where these types of elements abut rigid building foundations or isolated/suspended structures, differential movements should be anticipated. As a minimum, we recommend that flexible joints be provided where such elements abut the main structure to allow for differential movement at these locations. Where the potential for differential movement is objectionable, it may be beneficial to consider methods of reducing anticipated movements or to consider structurally suspending critical areas to match the adjacent building's performance.

PRELIMINARY PAVEMENT RECOMMENDATIONS

We have developed pavement thicknesses and construction recommendations based on the project design requirements, the pavement design parameters developed from the project borings and our experience with similar subgrade soils. Pavement design criteria and pavement design parameters for flexible and rigid pavement are presented in the following sections.

FLEXIBLE PAVEMENT DESIGN GUIDELINES

- Asphalt Institute guidelines followed for parking lot design of flexible pavement.
- Traffic Class = II for light duty pavement (50-500 spaces); 200 cars per day and 7,000 to 15,000 trucks during the design period.
- Traffic Class = III for heavy-duty pavement; 700 autos per day and 20 heavy trucks per day.
- A subgrade California Bearing Ratio (CBR) of 5.

The following recommendations for pavement sections are based on the above assumptions, published correlations, and our experience with similar soils.

Pavement Type	Material	Thickness
Automobile Parking (Light Duty)	Hot Mix Asphaltic Concrete (HMAC) over	1.5 inches
	Crushed Limestone or Crushed Concrete Base or	6 inches
	Black Base over	4 inches
	Lime Treated Subgrade (LTS)	6 inches
Entry/Exit Driveways and Drive-thru Lanes, Dumpster Pads, and Lift Points (Heavy Duty)	HMAC Over	2 inches
	Black Base or	5 inches
	Cement Treated Crushed Limestone or Crushed Concrete Base* over	8 inches
	LFS	6 inches

*Untreated aggregate base courses are not recommended for parking areas for heavy trucks.

RIGID PAVEMENT

Concrete pavement design for parking lots was performed in accordance with the American Concrete Institute (ACI) *Guide for Design and Construction of Concrete Parking Lots* (ACI Committee 330R-01). Based on an effective modulus of subgrade reaction (k) value of 100 pci, a concrete flexural strength of 500 psi, and the concrete thickness tables presented in Table 2.4 of ACI 330R, design concrete thicknesses for light duty, medium duty, and heavy duty pavement are presented below.

- Light Duty Pavement (Car Parking Areas, Traffic Category A, ADTT = 0), concrete design thickness = 5 inches
- Medium Duty Pavement (Drive Aisles, Traffic Category A-1, ADTT = 10), concrete thickness = 6 inches
- Heavy Duty Pavement (Driveways, Dumpster Areas and Truck Docks, Traffic Category B, ADTT = 25), concrete design thickness = 7 inches

ADTT = Average Daily Truck Traffic. Trucks are defined as vehicles with at least six wheels; excludes panel trucks, pickup trucks, and other four-wheel vehicles.

Using the previously referenced modulus of subgrade reaction value and the foregoing traffic volumes, the following rigid pavement reinforcement is recommended.

Maximum Individual Slab Dimension (Expansion Joint to Crack Control Joint)	= 12.5 feet by 12.5 feet (light duty)
Maximum Individual Slab Dimension (Expansion Joint to Crack Control Joint)	= 15 feet by 15 feet (heavy duty)
Reinforcement Size and Spacing	= No. 3 Bar, 18 inches on-centers each way
Load Transfer at Joints, Dowel Size	= 3/4-inch diameter smooth bars
Load Transfer at Joints, Dowel Length	= 16 inches (one end treated to slip)
Load Transfer at Joints, Dowel Spacing	= 12 inches on-centers along each joint

Traffic conditions are expected to vary at the site, with heavy traffic loads anticipated for the entrance drives and lighter traffic loads throughout the parking areas.

PAVEMENT CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

The pavement should be prepared in accordance with the recommendations presented in the *Site Preparation* subsection of the *Foundation Construction Considerations* section of this report.

DRAINAGE CONSIDERATIONS

As with any soil-supported structure, the satisfactory performance of a pavement system is contingent on the provision of adequate surface and subsurface drainage. Insufficient drainage which allows saturation of the pavement subgrade and/or the supporting granular pavement materials will greatly reduce the performance and service life of the pavement systems.

Surface and subsurface drainage considerations crucial to the performance of pavements at this site include (but are not limited to) the following:

- any known natural or man-made subsurface seepage at the site which may occur at sufficiently shallow depths as to influence moisture contents within the subgrade should be intercepted by drainage ditches or below grade drains;
- final site grading should eliminate isolated depressions adjacent to curbs which may allow surface water to pond and infiltrate into the underlying soils. Curbs should be installed to sufficient depth to reduce infiltration of water beneath the curbs, and;
- pavement surfaces should be maintained to help reduce surface ponding and to provide rapid sealing of any developing cracks. These measures will help reduce infiltration of surface water downward through the pavement section.

FLEXIBLE BASE COURSE

The flexible base course should be crushed limestone conforming to TxDOT Standard Specifications, Item 247, Type A or D, Grades 1 or 2. The base course should be placed in loose lifts with a maximum thickness of 8 in. and compacted to a minimum 95 percent of the maximum dry density at optimum moisture content \pm 2 percent as determined by ASTM D 1557.

ASPHALTIC CONCRETE SURFACE COURSE

The HMAC surface course should conform to TxDOT Standard Specifications, Item 340, Type D. The AC should be compacted to a minimum 92 percent of the maximum theoretical specific gravity (Rice) of the mixture determined according to Test Method Tex-227-F. Pavement specimens, which shall be either cores or sections of HMAC pavement, will be tested according to Test Method Tex-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from project roadway specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required roadway specimens at his expense and in a manner and at locations selected by the Engineer.

PORTLAND CEMENT CONCRETE

The PCC used for pavements should be air-entrained to result in a 4 percent plus/minus 1 percent air, a maximum slump of 5 inches, and a minimum 28-day compressive strength of 3,000 psi. A liquid membrane-forming curing compound should be applied as soon as practical after broom finishing the concrete surface. The curing compound will help reduce the loss of water from the concrete. The reduction in the rapid loss in water will help reduce shrinkage cracking of the concrete.

LIME TREATMENT OF SUBGRADE

In cohesive soils, lime may be used to treat the subgrade soils. Lime treatment of the cohesive subgrade soils should be in accordance with the TxDOT Standard Specifications, Item 260. For estimating purposes, we recommend that 6 to 7 percent hydrated lime by dry soil weight be assumed for treatment. Prior to construction, we recommend that the optimum lime content of the subgrade soils be determined by appropriate laboratory testing. Lime-treated subgrade soils should be compacted to a minimum of 95 percent of the maximum dry density at moisture content within the range of optimum moisture content to 3 percentage points above the optimum moisture content as determined by ASTM D698.

Recommendations provided herein include the use of lime treatment as a method to improve pavement subgrade conditions. We also recommend performing additional laboratory testing to determine the concentration of soluble sulfates in the subgrade soils, in order to investigate the potential for a recently reported adverse reaction to lime in certain sulfate-containing soils. The adverse reaction, referred to as sulfate-induced heave, has been known to cause cohesive subgrade soils to swell in short periods of time, resulting in pavement heaving and possible failure.

CONSTRUCTION RELATED SERVICES

CONSTRUCTION MATERIALS TESTING AND OBSERVATION SERVICES

As presented in the attachment to this report, *Important Information About Your Geotechnical Engineering Report*, subsurface conditions can vary across a project site. The conditions described in this report are based on interpolations derived from a limited number of data points. Variations will be encountered during construction, and only the geotechnical design engineer will be able to determine if these conditions are different than those assumed for design.

Construction problems resulting from variations or anomalies in subsurface conditions are among the most prevalent on construction projects and often lead to delays, changes, cost overruns, and disputes. These variations and anomalies can best be addressed if the geotechnical engineer of record, **RKCI**, is retained to perform construction observation and testing services during the construction of the project. This is because:

- **RKCI** has an intimate understanding of the geotechnical engineering report's findings and recommendations. **RKCI** understands how the report should be interpreted and can provide such interpretations on site, on the CLIENT's behalf.
- **RKCI** knows what subsurface conditions are anticipated at the site.
- **RKCI** is familiar with the goals of the CLIENT and project design professionals, having worked with them in the development of the geotechnical work scope. This enables **RKCI** to suggest remedial measures (when needed) which help meet the CLIENT's and the design teams' requirements.
- **RKCI** has a vested interest in client satisfaction, and thus assigns qualified personnel whose principal concern is client satisfaction. This concern is exhibited by the manner in which contractors' work is tested, evaluated and reported, and in selection of alternative approaches when such may become necessary.
- **RKCI** cannot be held accountable for problems which result due to misinterpretation of our findings or recommendations when we are not on hand to provide the interpretation which is required.

BUDGETING FOR CONSTRUCTION TESTING

Appropriate budgets need to be developed for the required construction testing and observation activities. At the appropriate time before construction, we advise that **RKCI** and the project designers meet and jointly develop the testing budgets, as well as review the testing specifications as it pertains to this project.

Once the construction testing budget and scope of work are finalized, we encourage a preconstruction meeting with the selected contractor to review the scope of work to make sure it is consistent with the construction means and methods proposed by the contractor. **RKCI** looks forward to the opportunity to provide continued support on this project, and would welcome the opportunity to meet with the Project Team to develop both a scope and budget for these services.

* * * * *

The following figures and appendix are attached and complete this report:

Figure 1	Boring Location Map
Figures 2 through 5	Logs of Borings
Figure 6	Key to Terms and Symbols
Figure 7	Results of Soil Sample Analyses
Figure 8	Allowable Axial Capacities for Drilled Shafts

ATTACHMENTS

Untitled Map

Write a description for your map.

Legend



B-3 20'

B-4 40'

B-1 20'

B-2 20'

Overture Sugar Land

Imperial Park



LOG OF BORING NO. B-1

Preliminary Study - 4.97-Acre Tract



Sugar land, Texas

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62739; W 95.64485

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT ²						PLASTICITY INDEX	% -200	
						0.5	1.0	1.5	2.0	2.5	3.0			3.5
SURFACE ELEVATION: Existing grade, ft														
			LEAN CLAY (CL), very stiff, dark brown, with roots										27	94
5			SILTY CLAY (CL-ML), soft, light brown		95								7	85
4				4										
4				4										
2				2										
2				2										
10														
15														
20														
Boring terminated at a depth of about 20-ft														
NOTES: Free-water was encountered at a depth of about 10.0-ft and rose to a depth of about 8.7-ft after 15 minutes														
25														
30														
35														
40														
45														
DEPTH DRILLED: 20.0 ft			DEPTH TO WATER: 8.7 ft			PROJ. No.: AHA21-067-00								
DATE DRILLED: 10/21/2021			DATE MEASURED: 10/21/21			FIGURE: 2								

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-2

Preliminary Study - 4.97-Acre Tract



Sugar land, Texas

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62722; W 95.64422

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT ²				PLASTICITY INDEX	% -200												
						0.5	1.0	1.5	2.0			2.5	3.0	3.5	4.0								
			SURFACE ELEVATION: Existing grade, ft																				
0			FAT CLAY (CH), stiff to firm, dark brown, with roots																				
5			-light brown from 4 ft to 6 ft		98																		
10			SANDY SILTY CLAY (CL-ML), soft, light brown	3 3																		4	55
15				2 2																			
20			SANDY FAT CLAY (CH), firm, medium stiff, dark brownish tan	6 6																			
20			Boring terminated at a depth of about 20-ft																				
25			NOTES: Free-water was encountered at a depth of about 9.0-ft and rose to a depth of about 8.5-ft after 15 minutes																				
30																							
35																							
40																							
45																							
DEPTH DRILLED:		20.0 ft		DEPTH TO WATER:		8.5 ft		PROJ. No.:		AHA21-067-00													
DATE DRILLED:		10/21/2021		DATE MEASURED:		10/21/21		FIGURE:		3													

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-3

Preliminary Study - 4.97-Acre Tract



Sugar land, Texas

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62793; W 95.64408

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT ²			PLASTICITY INDEX	% -200	
						0.5	1.0	1.5			2.0
			SURFACE ELEVATION: Existing grade, ft								
0			FAT CLAY (CH), very stiff, dark brown, with roots							39	97
5			LEAN CLAY (CL), soft, light brown	4	112					10	87
10				4							
15				2							
20			Boring terminated at a depth of about 20-ft	3							
25			NOTES: Free-water was encountered at a depth of about 9.4-ft and rose to a depth of about 7.7-ft after 15 minutes								
30											
35											
40											
45											

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 20.0 ft	DEPTH TO WATER: 7.7 ft	PROJ. No.: AHA21-067-00
DATE DRILLED: 10/21/2021	DATE MEASURED: 10/21/21	FIGURE: 4

LOG OF BORING NO. B-4

Preliminary Study - 4.97-Acre Tract



Sugar land, Texas

DRILLING METHOD: Straight Flight Auger & Mud Rotary

LOCATION: N 29.62753; W 95.64433

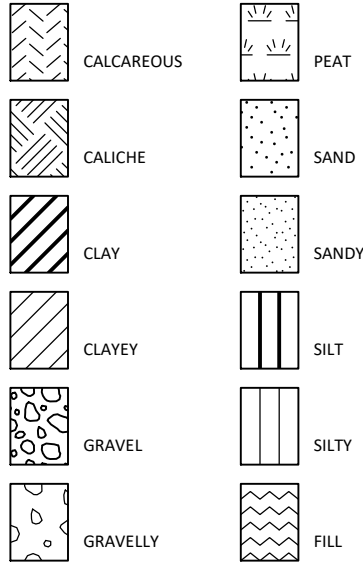
DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT ²			PLASTICITY INDEX	% -200
						0.5	1.0	1.5		
			SURFACE ELEVATION: Existing grade, ft							
			FAT CLAY (CH), firm, brown, w/ roots							
5					99					
			SANDY SILT (ML), very loose to loose, brown, w/ clayey silt	3					1	53
10				6						
15				6						
20			SILTY CLAYEY SAND (SC-SM), loose to very loose, brown	6					4	41
25				3						
30				5						
35			POORLY GRADED SAND w/ SILT (SP-SM), medium dense, dark gray	21						8
40			CLAYEY SAND (SC), medium dense, dark gray	18						
			Boring terminated at a depth of about 40-ft							
			NOTES: Free-water was encountered at a depth of about 10.0-ft and rose to about 9.2-ft after 5 minutes, and to 8.0-ft after 15-minutes							
DEPTH DRILLED:			40.0 ft	DEPTH TO WATER:			8.0 ft	PROJ. No.:		AHA21-067-00
DATE DRILLED:			11/16/2021	DATE MEASURED:			11/16/2021	FIGURE:		5

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

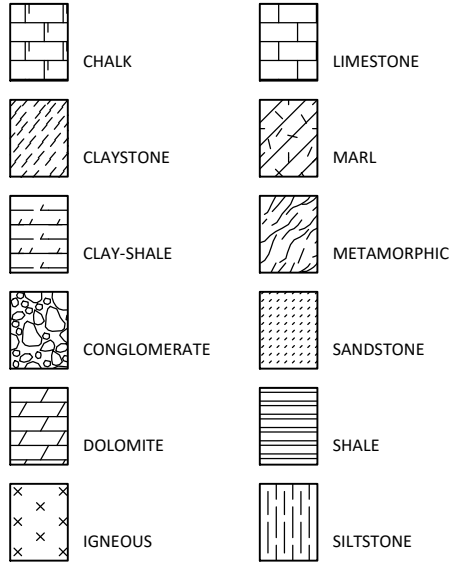
KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

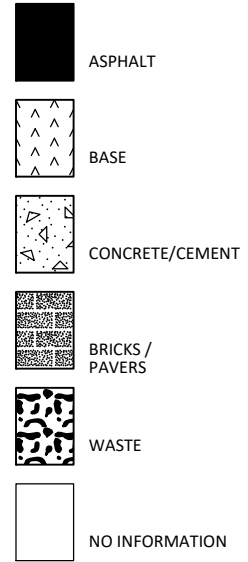
SOIL TERMS



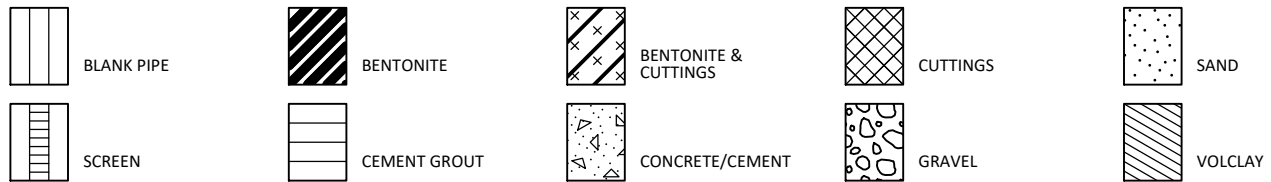
ROCK TERMS



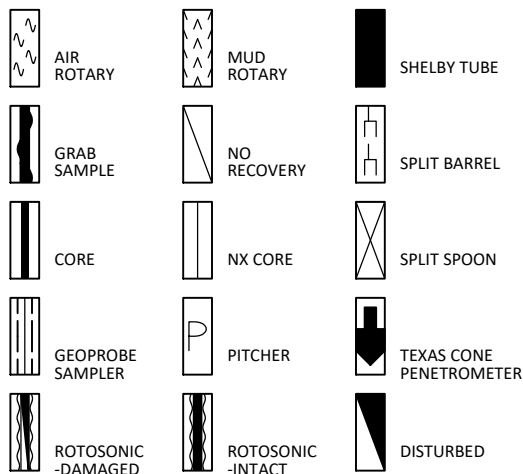
OTHER



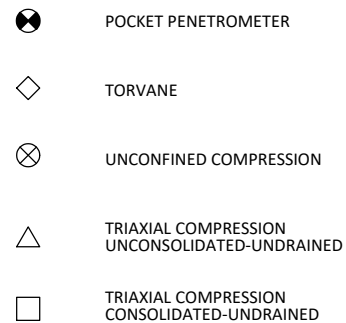
WELL CONSTRUCTION AND PLUGGING MATERIALS



SAMPLE TYPES



STRENGTH TEST TYPES



NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. AHA21-067-00

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

COHESIVE STRENGTH

PLASTICITY

<u>Penetration Resistance Blows per ft</u>	<u>Relative Density</u>	<u>Resistance Blows per ft</u>	<u>Consistency</u>	<u>Cohesion TSF</u>	<u>Plasticity Index</u>	<u>Degree of Plasticity</u>
0 - 4	Very Loose	0 - 2	Very Soft	0 - 0.125	0 - 5	None
4 - 10	Loose	2 - 4	Soft	0.125 - 0.25	5 - 10	Low
10 - 30	Medium Dense	4 - 8	Firm	0.25 - 0.5	10 - 20	Moderate
30 - 50	Dense	8 - 15	Stiff	0.5 - 1.0	20 - 40	Plastic
> 50	Very Dense	15 - 30	Very Stiff	1.0 - 2.0	> 40	Highly Plastic
		> 30	Hard	> 2.0		

ABBREVIATIONS

B = Benzene	Qam, Qas, Qal = Quaternary Alluvium	Kef = Eagle Ford Shale
T = Toluene	Qat = Low Terrace Deposits	Kbu = Buda Limestone
E = Ethylbenzene	Qbc = Beaumont Formation	Kdr = Del Rio Clay
X = Total Xylenes	Qt = Fluvial Terrace Deposits	Kft = Fort Terrett Member
BTEX = Total BTEX	Qao = Seymour Formation	Kgt = Georgetown Formation
TPH = Total Petroleum Hydrocarbons	Qle = Leona Formation	Kep = Person Formation
ND = Not Detected	Q-Tu = Uvalde Gravel	Kek = Kainer Formation
NA = Not Analyzed	Ewi = Wilcox Formation	Kes = Escondido Formation
NR = Not Recorded/No Recovery	Emi = Midway Group	Kew = Walnut Formation
OVA = Organic Vapor Analyzer	Mc = Catahoula Formation	Kgr = Glen Rose Formation
ppm = Parts Per Million	EI = Laredo Formation	Kgru = Upper Glen Rose Formation
	Kknm = Navarro Group and Marlbrook Marl	Kgrl = Lower Glen Rose Formation
	Kpg = Pecan Gap Chalk	Kh = Hensell Sand
	Kau = Austin Chalk	

PROJECT NO. AHA21-067-00

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

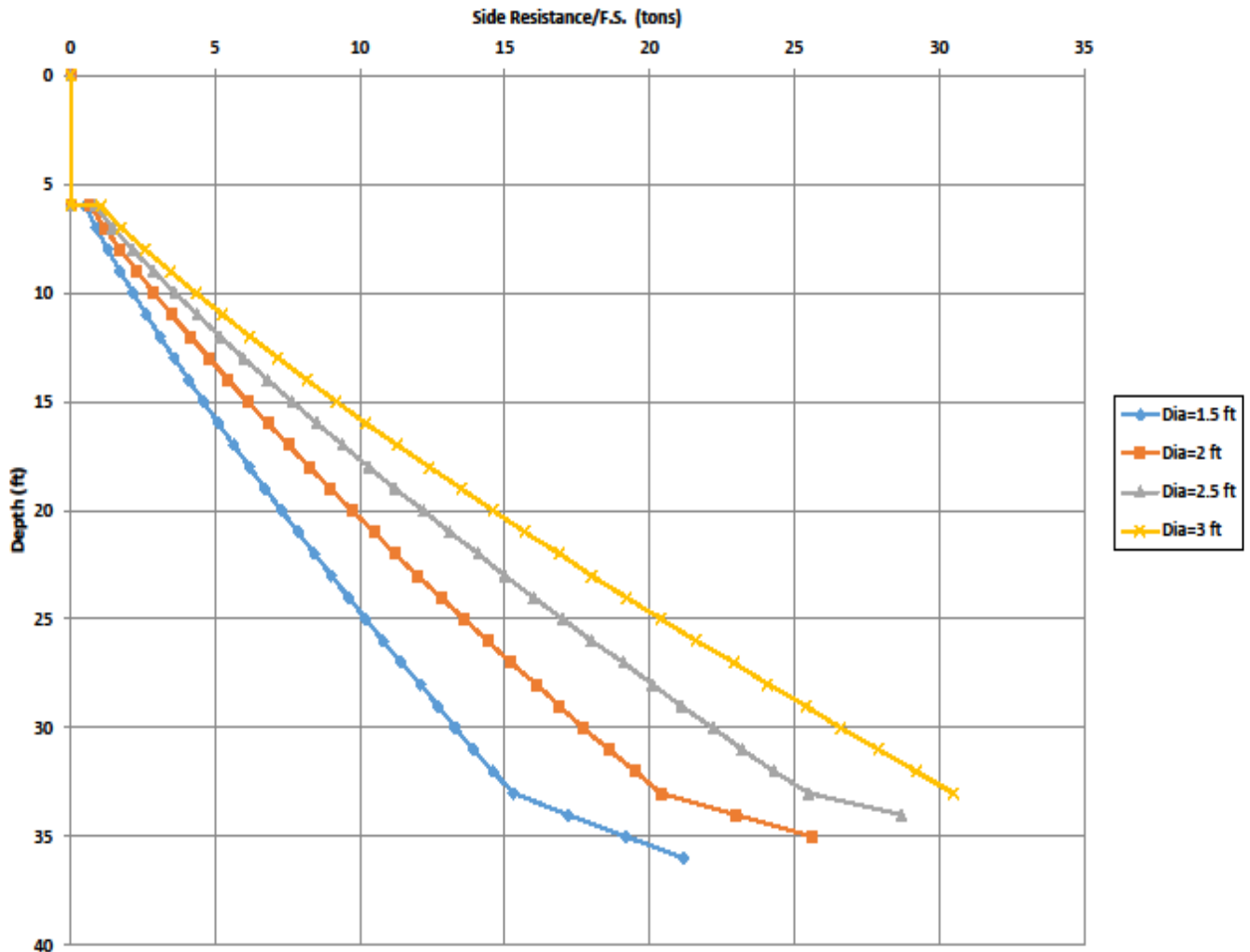
A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

<u>Blows Per Foot</u>	<u>Description</u>
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

Drilled Shaft Allowable Axial Capacities - Side Resistance Only



Notes:

1. Reference: FHWA-NHI-10-016 / FHWA GEC 010.
2. Factor of Safety (FS) =2 for allowable side resistance. End bearing has been neglected.
3. Side resistance from upper 5 ft depth disregarded to account for soil disturbance during construction and potential soil shrinkage around the pile within the zone of seasonal moisture variation.
4. Chart is for estimation purposes only. Additional information is required for final design including ground elevation at final grade and pile cutoff elevation.



Axial Capacity Chart for Drilled Shaft Sizes 18", 24", 36" and 30"
4.97-Acre Tract
Sugar Land, TEXAS

Figure 8

PROJECT NO. AHA21-067-00

BORING No.	DEPTH, FEET	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX	MINUS #200 SIEVE, %	COMPRESSIVE STRENGTH, TSF	FAILURE STRAIN, %	CONFINING PRESSURE, PSI	DEVIATOR STRESS, TSF	WET DENSITY, PCF	REMARKS
B-1	0	22		47	20	27	94						
B-1	2	30	94.7					2.4	2.8	0	1.2	122.8	
B-1	4	23		28	21	7	85						
B-1	6.5	22											
B-1	8.5	24											
B-1	13.5	28											
B-1	18.5	24											
B-2	0	31		76	28	48	94						
B-2	2	24	97.5					1.6	3.9		0.8	120.6	
B-2	4	25											
B-2	6	27											
B-2	8.5	28		22	18	4	55						
B-2	13.5	28											
B-2	18.5	27											
B-3	0	26		64	25	39	97						
B-3	2	18	111.7					2.0	5.5		1.0	131.4	
B-3	4.5	23		29	19	10	87						
B-3	6	29											
B-3	8.5	27											
B-3	13.5	29											
B-3	18.5	29											
B-4	0	23		58	19	39	98						
B-4	2	19											
B-4	4	25	98.8					0.7	10.3		0.3	123.2	
B-4	6	24		NP	NP	1	53						
B-4	8	25											
B-4	13	37											
B-4	18	29		22	18	4	41						
B-4	23	28											
B-4	28	30											
B-4	33	22					8						
B-4	38	26											

FIGURE 1

HCFCD LAB TEST SUMMARY AHA21-067-00.GPJ RKCI.GDT 11/24/21



3602 Westchase
Houston, Texas 77042
(713) 996-8990
(713) 996-8993 fax
www.rkci.com

LABORATORY SUMMARY

Preliminary Study - 4.97-Acre Tract
Sugar land, Texas

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply this report for any purpose or project except the one originally contemplated.*

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an

assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by:* the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help

others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your GBC-Member geotechnical engineer for more information.



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e-mail: info@geoprofessional.org www.geoprofessional.org

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ENGINEERING • ENVIRONMENTAL • INFRASTRUCTURE • PROJECT CONTROL

Austin, TX

▶ San Antonio, TX

Lake Worth, FL

Brownsville, TX

Houston, TX

Lincoln, NE

Dallas, TX

McAllen, TX

Salt Lake City, UT

Freeport, TX

New Braunfels, TX

Mexico

01 10 00

SUMMARY

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Project information.
 - 2. Work covered by the Contract Documents.
 - 3. Contractor duties.
 - 4. Work by Owner.
 - 5. Work under separate contracts.
 - 6. Owner-furnished products.
 - 7. Access to site.
 - 8. Protection of work and property.
 - 9. Owner's occupancy requirements.
 - 10. Specification formats and conventions.
 - 11. Provisions for electronic media.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

- A. Project Identification: Rosenberg Development Corporation Building.
 - 1. Project Location: Rosenberg, Texas
- B. Owner Identification: The City of Rosenberg, Texas.
- C. Architect Identification: The Contract Documents were prepared for the Project by AUTOARCH Architects, LLC, 6200 Savoy, Suite 100, Houston, TX 77036.
 - 1. Contact: Lina Sabouni
 - a. Telephone: (713) 952 – 3366.
 - b. Email: lina@autoarch.net

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of the Project is defined by the Contract Documents and consists of the following:
 - 1. Construction of a one-story, wood framed office building with approximately 4,500 sf of floor area and including related site improvements.
 - 2. Shall conform to and coordinate with Uniform General, Supplemental and Special Conditions.
 - 3. Drawings will be available to Contractor in PDF format for Contractor's use and distribution to subcontractors and suppliers.
- B. Project will be constructed under a single general construction contract

1.4 CONTRACTOR DUTIES

- A. VOC Compliance: Ensure that all assemblies, components, and systems comply with all VOC (Volatile Organic Components) requirements and regulations of the Environmental

Protection Agency (EPA) Occupational Safety Health Administration (OSHA), State, County, City, and Local Air Control District.

- B. Except as specifically noted, provide and pay for:
 - 1. Labor, materials, and equipment.
 - 2. Tools, construction equipment and machinery.
 - 3. Water, heat, and utilities required for construction.
 - 4. Other facilities and services necessary for proper execution and completion of work.
- C. Secure and pay for, as necessary for proper execution and completion of Work, and as applicable at time of receipt of bids:
 - 1. Building Permit.
 - 2. Licenses.
 - 3. Bonds
- D. Give required notices.
- E. Comply with all applicable local Building Codes, ordinances, rules, regulations, orders and other legal requirements of public authorities which bear on performance of Work.
- F. Promptly submit written notice to Architect of observed variance of Contract Documents from requirements of authorities having jurisdiction. Assume responsibility for Work performed without such notice known to be contrary to code or regulatory requirements.

1.5 WORK BY OWNER

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will not perform any construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
 - 1. Data Switches, and Security System Cabling and Security Equipment Installation. [Project Director and/or Architect may attach as appropriate detailed Equipment Responsibility Matrix.]
 - 2. Interior and exterior signage and water leak testing.
- C. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.
 - 1. Telephone Equipment, Audio Visual, Surveying, Geotechnical Study, Materials Testing, Test and Balance of HVAC System. Furniture and OPOI, FFE. [Project Director and/or Architect may attach as appropriate detailed Equipment Responsibility Matrix.]
- D. Subsequent Work: Owner will perform the following additional work at site after Substantial Completion. Completion of that work will depend on successful completion of preparatory work under this Contract.
 - 1. Materials testing, install interior and exterior signage and water leak testing.

1.6 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1.7 OWNER-FURNISHED, CONTRACTOR-INSTALLED PRODUCTS (REFER TO ARCHITECT PROGRAM AND DRAWINGS)

- A. Owner's and Contractor's Responsibilities:
1. Contractor shall provide support systems to receive Owner's equipment as well as plumbing, HVAC, and electrical connections.
 2. Owner will arrange for and deliver Shop Drawings, Product Data, and Samples to Contractor.
 3. Owner will arrange and pay for delivery of Owner-furnished items according to Contractor's Construction Schedule.
 4. After delivery, Owner will inspect delivered items for damage. Contractor shall be present for and assist in Owner's inspection.
 5. If Owner-furnished items are damaged, defective, or missing, Owner will arrange for replacement.
 6. Owner will arrange for manufacturer's field services and for delivery of manufacturer's warranties to Contractor.
 7. Owner will furnish Contractor the earliest possible delivery date for Owner-furnished products. Using Owner-furnished earliest possible delivery dates, Contractor shall designate delivery dates of Owner-furnished items in Contractor's Construction Schedule.
 8. Contractor shall review Shop Drawings, Product Data, and Samples and return them to Architect noting discrepancies or anticipated problems in use of product.
 9. Contractor is responsible for receiving, unloading, handling, and storing Owner-furnished items at Project site.
 10. Contractor is responsible for protecting Owner-furnished items from damage during storage and handling, including damage from exposure to the elements.
 11. If Owner-furnished items are damaged as a result of Contractor's operations, Contractor shall repair or replace them with new items.
 12. Contractor shall install and otherwise incorporate Owner-furnished items into the Work, including making building services connections.

1.8 ACCESS TO SITE

- A. Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project. Make each entity engaged in work on the project aware that the adjacent buildings house operating facilities that must continue in operation during the construction period, except as the Architect and Owner may otherwise direct.
- B. Confine operations at site to areas permitted by Law, Ordinances, Permits, and Contract Documents.
- C. Do not unreasonably encumber site with materials or equipment.
- D. Assume full responsibility for protection and safekeeping of products stored on premises.
- E. Move any stored products which interfere with operations of Owner or other contractors.
- F. Obtain and pay for use of additional storage or work areas needed for operations.
- G. Limit use of site for work and storage as follows:
1. Do not use completed paving areas for storage without Owner's approval.
 2. Do not store materials where trees are located.
 3. Restrict Work and storage to areas indicated on Drawings or approved by Owner.

4. Access site in areas approved by Owner.
 5. Restrict parking to areas approved by Owner.
 6. Do not perform operations that would interrupt or delay Owner's daily operations.
- H. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

1.9 PROTECTION OF WORK AND PROPERTY

- A. The Contractor shall maintain adequate protection of the Work from damage and shall protect the Owner's and adjacent property from injury or loss arising from the Work. Contractor shall provide and maintain at all times any OSHA-required danger signs, guards, and obstructions necessary to protect the public and construction personnel from any dangers inherent with or created by the Work in progress.
1. All federal, state, and city rules and requirements pertaining to safety, and all EPA standards, OSHA standards, and NESHAP regulations pertaining to asbestos as required shall be complied with.
- B. Twenty-four (24) Hour Call: The Contractor shall have personnel on call 24 hours per day, for emergencies during the course of the Project. The Owner shall be provided with a 24-hour emergency contact number of Contractor's personnel. Contractor shall be able to respond to any emergency call and have personnel on-site within two (2) hours after contact. Numbers to be made available to the Owner shall include home, office and mobile numbers for the following:
1. Contractor's project manager.
 2. Contractor's field superintendent.
 3. Owner or company officer of Contractor.

1.10 OWNER'S OCCUPANCY REQUIREMENTS

- A. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.
- B. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building.

1.11 SPECIFICATION FORMATS AND CONVENTIONS

- A. General: Specification requirements are to be performed by Contractor unless specifically stated otherwise.
1. The Specifications do not:
 - a. Establish trade jurisdictions or divisions of responsibility.
 - b. Do not define Subcontract scopes of work.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to and govern the Work of all Sections in the Specifications.
- C. Specification Format: The Specifications are organized into Divisions and Sections using the current version of CSI/CSC's "MasterFormat" 50-Division format and numbering system.
1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the Table of Contents at the

- beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.
2. The order of articles, paragraphs, subparagraphs, and sub-subparagraphs within the text any Specification section is defined by a sequence of indentations.
 - a. Article, paragraph and subparagraph titles, and other identifications of subject matter in the Specifications, are intended as an aid in locating and recognizing various requirements in the beginning words of a sentence.
 - b. Specification text shall govern over titling, and shall be understood to be and interpreted as a whole. Where a title establishes the subject, the titles are subordinate to and do not define, limit, or otherwise restrict the Specification text.
 3. The captions and headings of various subdivisions of the Contract Documents are intended only as a matter of reference and convenience for describing the Work and in no way define, prescribe or limit the scope or intent of the Contract Documents or any subdivision thereof.
- D. Specification Style: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - b. Contract Documents may omit modifying words such as "all" or "any", and articles such as "the" or "an". The absence of a modifier or article from one statement that appears in another is not intended to affect the interpretation of either statement.
- E. Specification Content: Drawings and general provisions of the Contract, including the Uniform General Supplemental and Special Conditions and Division 01 specification Sections, apply to the execution of the Work of subsequent specification sections, and vice versa.
1. Work specified in any one Section is related to, and dependent upon, Work specified in other Sections, whether or not specific reference is made to the Work of other Sections. Cross-references in the Specifications are general references intended as a matter of convenience for aiding in the location general information, and are not all-inclusive.
 2. Names, telephone numbers, and web-site addresses and other contact information listed in the Contract Documents are for convenience only, are subject to change, and are believed to be accurate and up-to-date as of the printing of the Contract Documents.
 3. Use of the word "including", when following any general statement, shall not be construed to limit such statement to specific items or matters listed, whether or not non-limiting language (such as "without limitation", "but not limited to", or other words of similar import) is used with reference thereto; but rather, shall be deemed to refer to all other items or matters that could reasonably fall within the broadest possible scope of such general statement.

1.12 PROVISIONS FOR ELECTRONIC MEDIA

- A. Project Website:
1. Construction Administration will be utilized through a Web-based Project Management System, Projectmates. This Owner-oriented management information system will provide a project participant the ability to track and manage the entire project. Projectmates will track communication between the Owner, Program Manager, Architect/Engineer, Design Consultants, Contractor and Subcontractors.
 2. The Architect/Engineer shall manage and coordinate the on-going electronic Construction Documents, tracking changes and incorporating same and maintaining current Construction Documents. The Architect/Engineer shall make these available to the Contractor and Owner as required.
 3. Projectmates key features that will be utilized are included but not limited to:
 4. Advanced reporting capabilities for the Owner
 5. Online RFIs and Submittals for the Contractor & Architect
 6. Online Field Reports for field inspectors
 7. Online Change Orders & contracts for the contract Manager
 8. Project Detail tracking:
 9. Notes
 10. Tasks
 11. Schedule
 12. Meetings
 13. Permits
 14. Storm water (SWPPP)
 15. Architect Field Observations
 16. Payment applications
 17. Constructability
 18. Online Project Directory
 19. Email-based alerts
 20. Task Management
 21. Site Photographs / Image Gallery
 22. Multi-tiered User Access
 23. Role-based security & permissions
 24. Advanced error tracking
 25. Final Project Archive
- B. Electronic Drawing Documents:
1. Electronic file copies of the Contract Drawings in latest AutoCAD in electronic format approved by LSC format may be obtained from the Architect. Contact Architect to determine availability of CAD documents and costs.
 2. Liability release and transfer agreement shall be executed and submitted by Contractor prior to turn-over of electronic files. Refer to Agreement Form included at end of Section 01 33 00.

PART 2 PRODUCTS - Not applicable to this Section

PART 3 EXECUTION - Not applicable to this Section

END OF SECTION

01 25 00

SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting and processing product substitutions after execution of the Agreement.
- B. For administrative and procedural requirements for product substitutions during the procurement process and prior to execution of the Agreement, refer to the Owner Provided Front End Documents.
- C. Where the Owner Provided Front End Documents and Division 00 provide requirements for substitution that conflict with this section, the more stringent shall govern. The Architect shall interpret the requirements of these sections and shall be the final authority in deciding whether a substitution shall be accepted.
 - 1. Regardless of any conflict, the Substitution Request Form following this section must be completed by the Contractor for all substitution issues.

1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitution requests will only be considered prior to receipt of Bids except when a specified product or system is no longer available.
 - 2. Owner-requested cost-reduction proposals shall be submitted on Substitution Request Form.

1.3 DESIGN REQUIREMENTS

- A. Materials, products, and equipment included in the Contract Documents are specified for the purpose of establishing a minimum standard of quality, cost, appearance, design, and function. It is not the intent to limit the acceptance of materials, products or equipment specified, but rather to name or describe a material, product or piece of equipment as the absolute minimum standard that is desired and acceptable. Where proprietary names are used, whether or not followed by the words "or acceptable substitution," requests for substitution will nevertheless be considered if properly submitted to and received by the Architect prior to the designated date.

1.4 SUBMITTALS

- A. Substitution Requests after Award of Contract: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
- B. The Substitution Request Form included as an attachment to this Document shall be used for all Substitution requests. Failure to use the attached Substitution Request form, or failure to fully execute the form as required, will result in rejection of the proposed substitution request without review.
 - 1. Do not make substitution request with shop drawings or product data submittals.

- C. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
1. Statement indicating why specified material or product cannot be provided.
 2. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 3. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 5. Samples, where applicable or requested.
 6. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 7. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 8. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
 9. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
 10. Cost information, including a proposal of change, if any, in the Contract Sum.
 11. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
 12. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 13. Only one substitution request will be reviewed for each product or system.

PART 2 PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

- A. Timing: Architect will consider requests for substitution if received within 60 days after award of Contract. Requests received after that time may be considered or rejected at the discretion of Architect.
- B. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 2. Requested substitution does not require extensive revisions to the Contract Documents.
 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 4. Substitution request is fully documented and properly submitted.
 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.

7. Requested substitution is compatible with other portions of the Work.
 8. Requested substitution has been coordinated with other portions of the Work.
 9. Requested substitution provides specified warranty.
- C. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

- A. All requests shall originate from the Contractor. Manufacturers, manufacturer's representatives, dealers, distributors, suppliers, and subcontractors shall not direct or make requests to substitute equipment or materials.
- B. Substitutions shall be submitted to the Architect only; no substitutions shall be submitted directly to any consultant, the Owner, or any of the Owner's consultants.
- C. All requests for substitutions shall be accompanied by manufacturer's product data, specifications, drawings, catalog cuts, samples, installation instructions, performance data, list of projects completed of similar size and scope, and other references and information necessary to completely describe the item, and to facilitate a thorough and complete review by the Architect. Requests not meeting all these requirements may be rejected without evaluation.

3.2 ARCHITECT'S ACTION

- A. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
- B. Approval, if granted, will be based upon reliance upon data submitted and the opinion, knowledge, information, and belief of the Architect at the time decision is rendered. Approval, therefore, is interim in nature and subject to reevaluation and reconsideration as additional data, materials, workmanship, and coordination with other work are observed and reviewed. In proposing items for consideration, Contractor assumes all risk, costs, and responsibility for item's final acceptance, compliance with the Contract Documents, integration into the Work, and performance.

3.3 IMPLEMENTATION

- A. Form of Acceptance: Change Order.
- B. If Architect cannot make a decision on use of a proposed substitution within time allocated,

or if substitution request is rejected, provide the basis of design product originally specified.

- C. If an accepted substitution is later found to be not in compliance with the Contract Documents, Contractor shall remove the substituted product, material, or item and provide the originally-specified product at no additional cost to Owner.

3.4 ATTACHMENTS

- A. Refer to Section 01 25 00x for Post-Award Substitution Request Form.

END OF SECTION

01 25 00x

SUBSTITUTION REQUEST FORM

(After Contract Award)

PROJECT: _____

TO: _____

FROM: _____

NO.: _____

DATE: _____

Contractor hereby requests acceptance of the following product or system as a substitution in accordance with provisions of Section 01 25 00 of the Specifications:

1. SPECIFIED PRODUCT OR SYSTEM

Substitution request for: _____

Specification Section No.: _____ Article / Paragraph: _____

2. REASON FOR SUBSTITUTION REQUEST

SPECIFIED PRODUCT:

- Is no longer available
- Is unable to meet Project Schedule
- Is unsuitable for the designated application
- Cannot interface with adjacent materials
- Is not compatible with adjacent materials
- Cannot provide the specified warranty
- Cannot be constructed as indicated
- Cannot be obtained due to one or more of the following:
 - Strike
 - Bankruptcy of manufacturer or supplier
 - Lockout
 - Similar occurrence (explain below)
- Will reduce construction time
- Will result in cost savings of \$ _____ to project
- Is for supplier's convenience
- Is for subcontractor's convenience
- Other: _____

3. SUPPORTING DATA

- Drawings, specifications, product data, performance data, test data, and any other necessary information to facilitate review of the Substitution Request is attached.
- Sample is attached.
- Sample will be sent if requested.

4. QUALITY COMPARISON

Provide all necessary side-by-side comparative data as required to facilitate review of Substitution Request:

	SPECIFIED PRODUCT	PROPOSED PRODUCT
Manufacturer:	_____	_____
Name / Brand:	_____	_____
Catalog No.:	_____	_____
Vendor:	_____	_____
Variations:	_____	_____

(Add Additional Sheets If Necessary)

Local Distributor or Supplier: _____

Maintenance Service Available: Yes No Warranty: Yes No _____ Years

Available Warranty Exceeds that of Specified Product: Yes No

Spare Parts Source: _____

5. PREVIOUS INSTALLATIONS

Identification of at least **four** similar projects on which proposed substitution was used:

Note: All questions must be answered and all blanks filled in.

PROJECT #1:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #2:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #3:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #4:

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

6. EFFECT OF SUBSTITUTION

Proposed substitution affects other work or trades: No Yes (if yes, explain)

Proposed substitution requires dimensional revisions or redesign of architectural, structural, M-E-P, life safety, or other work: No Yes (if yes, attach data explaining revisions)

7. STATEMENT OF CONFORMANCE OF REQUEST TO CONTRACT REQUIREMENTS

Contractor and Subcontractor have investigated the proposed substitution and hereby represent that:

- A. They have personally investigated the proposed substitution and believe that it is equal to or superior in all respects to specified product, except as stated above;
- B. The proposed substitution is in compliance with applicable codes and ordinances;
- C. The proposed substitution will provide same warranty as specified for specified product;
- D. They will coordinate the incorporation of the proposed substitution into the Work, and will include modifications to the Work as required to fully integrate the substitution;
- E. They have included complete cost data and implications of the substitution (attached);
- F. They will pay any redesign fees incurred by the Architect or any of the Architect's consultants, and any special inspection costs incurred by the Owner, caused by the use of this product;
- G. They waive all future claims for added cost or time to the Contract related to the substitution, or that become known after substitution is accepted.
- H. The Architect's approval, if granted, will be based upon reliance upon data submitted and the opinion, knowledge, information, and belief of the Architect at the time decision is rendered and Addendum is issued; and that Architect's approval therefore is interim in nature and subject to reevaluation and reconsideration as additional data, materials, workmanship, and coordination with other work are observed and reviewed.

Bidding Contractor: _____
(Name of prime bidding contractor)

Date: _____ By: _____

Note: Unresponsive or incomplete requests will be rejected and returned without review.

8. ARCHITECT'S REVIEW AND ACTION

- Substitution is accepted.
 - Substitution is accepted, with the following comments: _____
-

- Resubmit Substitution Request; Provide more information in the following areas:
 - Provide proposal indicating amount of savings / credit to Owner
 - Bidding Contractor shall sign Bidder's Statement of Conformance
 - Bidding Subcontractor shall sign Bidder's Statement of Conformance
 - Other: _____
-

- Substitution is not accepted:
 - Substitution Request received too late.
 - Substitution Request received directly from subcontractor or supplier.
 - Substitution Request not submitted in accordance with requirements.
 - Substitution Request Form is not properly executed.
 - Substitution Request does not indicate what item is being proposed.
 - Insufficient information submitted to facilitate proper evaluation.
 - Proposed product does not appear to comply with specified requirements.
 - Proposed product will require substantial revisions to Contract Documents.

Architect

Date: _____ By: _____

Architect has relied upon the information provided by the Contractor, and makes no claim as to the accuracy, completeness, or validity of such information. If an accepted substitution is later found to be not in compliance with the Contract Documents, Contractor shall provide the specified product.

9. OWNER'S REVIEW AND ACTION

- Substitution is accepted. Architect to prepare Change Order.
- Substitution is not accepted.
- Owner will pay Architect directly for redesign fees.
- Include Architect Additional Service fee for implementing the substitution in the Change Order.

Date: _____ By: _____
(Owner's Representative)

END OF SECTION

01 26 13

REQUESTS FOR INFORMATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative provisions for submitting and processing Requests for Information (RFIs) after execution of the Agreement:

1.2 DEFINITIONS

- A. RFI: Request from Contractor seeking Information or clarification of the Contract Documents.

1.3 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS

- A. General: Carefully study and compare Contract Documents with existing conditions at Project site and shall at once report in writing to Architect any error, inconsistency or omission discovered or any materials, systems, procedures, or methods of construction, either shown on the Drawings or specified, which the Contractor feels are incorrect, inadequate, obsolete, or unsuitable for purpose intended.
- B. Before starting each portion of the Work, carefully study and compare the various Drawings and other Contract Documents related to that portion of the Work, and information furnished by the Owner, take field measurements of existing conditions related to that portion of the Work, and observe conditions at the site.
- C. Any errors, discrepancies, inconsistencies, or omissions discovered shall be promptly reported to the Architect as a request for Information.
1. Contractor shall not proceed with the Work without written clarification from the Architect.
- D. In the case of conflicts or discrepancies between Drawings and Specifications, or within either Document not clarified by Addendum, promptly submit written request to the Architect as a request for Information.
1. Contractor shall not proceed with the Work without written clarification from the Architect.
- E. Contractor shall request clarification in sufficient time to avoid delays and increases in the Contract Sum.
- F. Contractor's failure to report discrepancies or omissions in the Contract Documents, or Contractor- or Subcontractor-generated assumptions, in lieu of Architect-issued clarifications regarding the intent of the Contract Documents, shall not be used a basis for future claims once the apparent discrepancies or omissions have been reconciled by appropriate Information issued by the Architect.

1.4 REQUESTS FOR INFORMATION (RFIS)

- A. Procedure: Immediately on discovery of the need for Information of the Contract Documents, and if not possible to request Information at Project meeting, prepare and submit an RFI in the form specified.
1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor

- will be returned with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing Information and the following:
1. Project name
 2. Date
 3. Name of Contractor
 4. Name of Architect
 5. RFI number, numbered sequentially
 6. Specification Section number and title and related paragraphs, as appropriate
 7. Drawing number and detail references, as appropriate
 8. Field dimensions and existing conditions, as appropriate
 9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 10. Contractor's signature
 11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing Information.
 - a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
- C. Hard-Copy RFIs: CSI Form 13.2A included at end of this Section.
1. Identify each page of attachments with the RFI number and sequential page number.
- D. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- E. Architect's Action: Architect and PD will review each RFI, determine action required, and return it. Allow three working days for Architect's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day. If more time or more information is needed, the RFI should be returned by the Architect within the 3 day period, stating such.
1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals
 - b. Requests for approval of substitutions
 - c. Requests for coordination information already indicated in the Contract Documents
 - d. Requests for adjustments in the Contract Time or the Contract Sum
 - e. Requests for Information of Architect's actions on submittals
 - f. Incomplete RFIs or RFIs with numerous errors
 2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
 4. RFIs involving request for remedial action to correct nonconforming work, which are returned in more than fourteen working days, are not eligible for Contractor's request for an increase in Contract Sum or an extension of Contract Time.

5. Where any action or response falls due on a Saturday, Sunday, or legal holiday, such action or response shall be considered due on the next business day which is not a Saturday, Sunday or a legal holiday.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within ten days if Contractor disagrees with response.
- G. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit updated log at each Construction Progress Meeting. Provide software log with not less than the following:
 1. Project name
 2. Name and address of Contractor
 3. Name and address of Architect
 4. RFI number including RFIs that were dropped and not submitted
 5. RFI description
 6. Date the RFI was submitted.
 7. Date Architect's response was received
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ATTACHMENTS

- A. Refer to Section 01 26 13x for Request for Information, CSI Form 13.2A.

END OF SECTION



REQUEST FOR INTERPRETATION

Project: _____

R.F.I. Number: _____

From: _____

To: _____

Date: _____

A/E Project Number: _____

Re: _____

Contract For: _____

Specification Section:

Paragraph:

Drawing Reference:

Detail:

Request:

Signed by:

Date:

Response:

Attachments

Response From:

To:

Date Rec'd:

Date Retrd:

Signed by:

Date:

Copies: Owner Consultants _____ _____ _____ _____ File

01 31 00

PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Coordination Drawings.
 - 3. Administrative and supervisory personnel.
 - 4. Conservation.
 - 5. Project meetings.
- B. Related Sections include Division 01, Section "Requests for Information" for administrative procedures for handling RFIs.

1.2 COORDINATION

- A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, which depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to:
 - 1. Preparation of Contractor's Construction Schedule
 - 2. Preparation of the Schedule of Values
 - 3. Installation and removal of temporary facilities and controls
 - 4. Delivery and processing of submittals
 - 5. Progress meetings
 - 6. Pre-installation conferences
 - 7. Project closeout activities
- D. Conservation: Coordinate construction activities to ensure that operations are carried out

with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Refer to Section 01 31 06.
- B. Staff Names: Within 15 days of starting construction operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
 1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

1.4 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1.5 PROJECT MEETINGS

- A. General: Contractor shall schedule and conduct weekly meetings with subcontractor's foremen and regular Project progress meetings/conferences with Project Manager and Architect at Project site, unless otherwise indicated.
 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times minimum of five business days prior to meeting date.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Project Manager, and Architect, within three days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
 1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule
 - b. Phasing
 - c. Critical work sequencing
 - d. Designation of responsible personnel
 - e. Procedures for processing field decisions and Change Orders
 - f. Procedures for processing Applications for Payment
 - g. Distribution of the Contract Documents
 - h. Submittal procedures
 - i. Preparation of Record Documents

- j. Use of the premises
 - k. Responsibility for temporary facilities and controls
 - l. Parking availability
 - m. Office, work, and storage areas
 - n. Equipment deliveries and priorities
 - o. First aid
 - p. Security
 - q. Progress cleaning
 - r. Working hours
 - s. Emerging Technologies and Procedures
 - t. Inspection required at Substantial Completion for Texas Department of Licensing and Regulations requirements for Texas Accessibility Standards compliance. Refer to Section 01 77 00.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents
 - b. Options
 - c. Related Change Orders
 - d. Submittals
 - e. Review of mockups
 - f. Possible conflicts
 - g. Compatibility problems
 - h. Time schedules
 - i. Weather limitations
 - j. Manufacturer's written recommendations
 - k. Warranty requirements
 - l. Compatibility of materials
 - m. Acceptability of substrates
 - n. Temporary facilities and controls
 - o. Space and access limitations
 - p. Regulations of authorities having jurisdiction
 - q. Testing and inspecting requirements
 - r. Required performance results
 - s. Protection of construction and personnel
 - 3. Record significant conference discussions, agreements, and disagreements.
 - 4. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
- 1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for

discussion as appropriate to status of Project.

- a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
- b. Review present and future needs of each entity present, including the following:
 - 1) Two week look ahead schedule
 - 2) Interface requirements
 - 3) Sequence of operations
 - 4) Status of submittals
 - 5) Deliveries
 - 6) Off-site fabrication
 - 7) Access
 - 8) Site utilization
 - 9) Temporary facilities and controls
 - 10) Work hours
 - 11) Progress cleaning
 - 12) Status of correction of deficient items
 - 13) Field observations
 - 14) RFIs.
 - 15) Status of proposal requests
 - 16) Pending changes
 - 17) Change Orders
 - 18) Documentation of information for payment requests.
3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 PRODUCTS - Not applicable to this Section

PART 3 EXECUTION - Not applicable to this Section

END OF SECTION

01 32 00

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Preliminary Construction Schedule
 - 2. Contractor's Construction Schedule
 - 3. Submittals Schedule
 - 4. Daily construction reports
 - 5. Material location reports
 - 6. Field condition reports
 - 7. Special reports

- B. Related Sections include the following:
 - 1. Division 01, Section "Payment Procedures" for submitting the Schedule of Values
 - 2. Division 01, Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes
 - 3. Division 01, Section "Submittal Procedures" for submitting schedules and reports
 - 4. Division 01, Section "Photographic Documentation" for submitting construction photographs

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 - 2. Predecessor activity is an activity that must be completed before a given activity can be started.

- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

- C. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.

- D. Event: The starting or ending point of an activity.

- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

- F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- G. Major Area: A story of construction, a separate building, a separate wing, a major department, or a similar significant construction element.
- H. Milestone: A key or critical point in time for reference or measurement.
- I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
 - 1. Scheduled date for first submittal
 - 2. Specification Section number and title
 - 3. Submittal category (action or informational)
 - 4. Name of subcontractor
 - 5. Description of the Work covered
 - 6. Scheduled date for Architect's final release or approval
- C. Preliminary Construction Schedule: Submit two printed copies; one a single sheet of reproducible media, and one a print.
- D. Contractor's Construction Schedule: Submit two printed copies of initial schedule, one a reproducible print and one a blue- or black-line print, large enough to show entire schedule for entire construction period.
 - 1. Submit an electronic copy of schedule, as required by owner. Include type of schedule (Initial or Updated) and date on label.
- E. CPM Reports: Concurrent with CPM schedule, submit three printed copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.
 - 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
- F. Daily Construction Reports: Submit two copies at weekly intervals.
- G. Material Location Reports: Submit two copies at monthly intervals.
- H. Field Condition Reports: Submit two copies at time of discovery of differing conditions.
- I. Special Reports: Submit two copies at time of unusual event.

1.4 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:
1. Review software limitations and content and format for reports.
 2. Verify availability of qualified personnel needed to develop and update schedule.
 3. Discuss constraints, including phasing, work stages, area separations, and interim milestones.
 4. Review delivery dates for Owner-furnished products.
 5. Review time required for review of submittals and resubmittals.
 6. Review requirements for tests and inspections by independent testing and inspecting agencies.
 7. Review time required for completion and startup procedures.
 8. Review and finalize list of construction activities to be included in schedule.
 9. Review submittal requirements and procedures.
 10. Review procedures for updating schedule.

1.5 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from parties involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 PRODUCTS

2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.
 4. Submittals Schedule shall be submitted as one of the conditions precedent to the Architect releasing CAD files for Contractor's use. Refer to Division 01 Section "Submittal Procedures" and Appendix 'A' – Electronic Drawing File Transfer Agreement Form, attached thereto.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning &

Scheduling."

- B. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.
- C. Time Frame: Extend schedule from date established for commencement of the Work.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- D. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 - 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 - 4. Startup and Testing Time: Include not less than 14 days for startup and testing.
 - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
- E. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
 - 1. Work under More Than One Contract: Include a separate activity for each contract.
 - 2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 - 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary of Work." Delivery dates indicated stipulate the earliest possible delivery date. Indicate latest possible delivery date that will not affect critical path.
 - 4. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction
 - b. Limitations of continued occupancies
 - c. Uninterruptible services
 - d. Use of premises restrictions
 - e. Provisions for future construction
 - f. Seasonal variations
 - g. Environmental control
 - 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards
 - b. Submittals
 - c. Purchases
 - d. Mockups
 - e. Fabrication
 - f. Sample testing
 - g. Deliveries
 - h. Installation
 - i. Tests and inspections
 - j. Adjusting
 - k. Curing

- l. Minimum 90-day drying time of concrete floors prior to installation of floor finishes (Refer to Section 09 05 65)
 - m. Pre-installation moisture and alkalinity testing for non-breathable floor finishes (Refer to Section 09 05 65)
 - n. Startup and placement into final use and operation
 - 6. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion
 - b. Permanent space enclosure
 - c. Completion of mechanical installation
 - d. Completion of electrical installation
 - e. Substantial Completion
- F. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- G. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
 - 1. Refer to Division 01 Section "Payment Procedures" for cost reporting and payment procedures.
- H. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

2.3 PRELIMINARY CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for commencement of the work.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.
 - 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 4. Use "one workday" as the unit of time.
- C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals
 - b. Purchase of materials
 - c. Delivery
 - d. Fabrication
 - e. Installation
 2. Processing: Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 3. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
- D. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity
 2. Description of activity
 3. Principal events of activity
 4. Immediate preceding and succeeding activities
 5. Early and late start dates
 6. Early and late finish dates
 7. Activity duration in workdays
 8. Total float or slack time
 9. Average size of workforce
 10. Dollar value of activity (coordinated with the Schedule of Values)
- E. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed
 2. Changes in early and late start dates
 3. Changes in early and late finish dates
 4. Changes in activity durations in workdays
 5. Changes in the critical path
 6. Changes in total float or slack time
 7. Changes in the Contract Time
 8. Schedule early completion of areas in accordance with Phasing requirements. Refer to Section 01 11 00.
- F. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.5 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site
 2. List of separate contractors at Project site
 3. Approximate count of personnel at Project site
 4. High and low temperatures and general weather conditions
 5. Accidents
 6. Meetings and significant decisions
 7. Unusual events (refer to special reports)
 8. Stoppages, delays, shortages, and losses
 9. Meter readings and similar recordings
 10. Emergency procedures
 11. Orders and requests of authorities having jurisdiction
 12. Change Orders received and implemented
 13. Construction Change Directives received
 14. Services connected and disconnected
 15. Equipment or system tests and startups
 16. Partial Completions and occupancies
 17. Substantial Completions authorized
- B. Material Location Reports: At monthly intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information in accordance with provisions of Section 01 26 13. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report electronically (as required by owner) to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule including a two week "look ahead" concurrently with the report of each such meeting.

2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate Actual Completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final completion construction photographs.
 - 4. Demonstration and training video recordings.
- B. Related Sections include the following:
 - 1. Division 01, Section "Submittal Procedures" for submitting photographic documentation.
 - 2. Division 01, Section "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.
 - 3. Division 01, Section "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
 - 4. Division 31, Section "Site Clearing" for photographic documentation before site clearing operations can commence.

1.2 INFORMATIONAL SUBMITTALS

- A. FAA Requirements:
 - 1. Current FAA Certified Drone Pilot License according to 14 CFR 107, Subpart C – Remote Pilot Certification.
 - 2. Current FAA Registration if drone weighs more than 0.55 pounds
- B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- C. Construction Photographs: Submit image files of each photographic view within three days of taking photographs.
 - 1. Digital Camera: Minimum sensor digital or high definition.
 - 2. Format: Minimum 1600 by 1200 pixels, 400 dpi minimum, in unaltered original files, with same aspect ratio as the sensor, uncropped, date- and time- stamped, in folder named by date of photograph, accompanied by key plan file.
 - 3. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project
 - b. Name and address of photographer
 - c. Name of Architect
 - d. Name of Contractor
 - e. Date photograph was taken
 - f. Description of vantage point, indicating location, direction (by

- compass point), and elevation or story of construction
 - g. Unique sequential identifier keyed to accompanying key plan
 - D. Construction Photographs: Submit approved electronic media and photo views concurrent with Application for Payment.
 - 1. Format shall be owner approved electronic media.
 - 2. Identification: Provide the following information: properties of the submitted electronic media (example below).
 - a. Name of Project
 - b. Name of Architect
 - c. Name of Contractor
 - d. Date photograph was taken
 - e. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - f. Unique sequential identifier keyed to accompanying key plan.
 - E. Video Recordings: Submit two copies of each video recording within seven days of recording. Coordinate with Owner for all final media submissions.
 - 1. Submit video recordings in digital video format acceptable to Owner.
 - 2. Identification: For each copy (electronic or disc), provide the following information:
 - a. Name of Project
 - b. Name of Architect
 - c. Name of Contractor
 - d. Date video recording was made
 - e. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - f. Weather conditions at time of recording.
- 1.3 ON MONTHLY BASIS, PROVIDE AERIAL PHOTOS FROM TWO DIFFERENT VIEWS AND DELIVER TO LSCS.
 - A. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities including temporary lighting required to produce clear, well-lit photographs without obscuring shadows.
- 1.4 USAGE RIGHTS
 - A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 6.0 megapixels, and at an image resolution of not less than 1600 by 1200 pixels.
- B. Digital Video Recording Format: Provide high-resolution, digital video disc in format acceptable to Owner.
 - 1. Recording quality shall be adequate to create photographic prints to be made from individual frames.

PART 3 EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.

- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 - 1. Date and Time: Include date and time in filename for each image.
 - 2. Field Office Images: Maintain one set of images in Owner approved media format in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.

- C. Preconstruction Photographs: Before commencement of site clearing, excavation and demolition, take color print and digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag excavation areas and construction limits before taking construction photographs.
 - 2. Take twelve photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take twelve photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

- D. Periodic Construction Photographs: Take 12 color print and digital photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

- E. Monthly UAV Drone Progressions:
 - 1. Comply with the safety requirements of 14 CFR 107. Include both panoramic and aerial video of the entire project captured monthly.
 - 2. Do not fly the drone higher than 400 feet.
 - 3. Photograph the 8 cardinal directions around the site perimeter and one top down, edited for proper exposure for allowing view of the entire site.
 - 4. Use the following personnel for all drone progressions:
 - a. Remote Pilot in Command: Responsible for the operation of the small unmanned aircraft system.
 - b. Visual Observer: Maintain unaided sight and position of small unmanned aircraft during flight.

- F. Final Completion Construction Photographs: Take twelve color photographs after date of Substantial Completion for submission as Project Record Documents. Architect will direct photographer for desired vantage points.

- G. Additional Photographs: Architect may issue requests for additional photographs, in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:

- a. Special events planned at Project site.
- b. Immediate follow-up when on-site events result in construction damage or losses.
- c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
- d. Substantial Completion of a major phase or component of the Work.
- e. Extra record photographs at time of final acceptance.
- f. Owner's request for special publicity photographs.

3.2 CONSTRUCTION VIDEO RECORDINGS

- A. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.
- B. Preconstruction Videotape: Before starting site clearing, excavation, and selective site demolition, record videotape of Project site and surrounding properties from different vantage points, as directed by Architect.
 1. Flag excavation areas and construction limits before recording construction videotapes.
 2. Show existing conditions adjacent to Project site before starting the Work.
 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions prior to the start of site clearing, excavation, and selective site demolition.
 4. Show protection efforts by Contractor.
- C. Periodic Construction Video Recordings: Record video recording monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time shall be a minimum of 30 minutes(s) to 24 hours.

END OF SECTION

01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's approval. Submittals may be rejected for not complying with requirements.

1.3 PROVISION AND USE OF ELECTRONIC FILES

- A. General: Electronic CAD files of the Contract Drawings will NOT be furnished by Architect for Contractor's use in preparing submittals unless procedures stated within the attached Appendix A are agreed to by all parties and all parties sign the Agreement Form, and the Contractor properly prepares and submits the Submittals Schedule as indicated in Division 01, Section "Construction Progress Documentation."
- B. Release of electronic drawing files are conditional upon the following:
1. The drawings represented in the CAD files are not Contract Documents.
 2. Files generally available for transfer will be limited to an impediments file as described in the Agreement.
 3. Only one set of electronic drawing files will be furnished; Contractor assumes responsibility for distributing pertinent files to the various subcontractors.
 4. The electronic drawing files have been developed without the assistance or specific expertise of the individual subcontractors and installers, and therefore do not account for or incorporate means, methods, shop standards, and routing economies required by individual subcontractors for the scope of work required by the finished Work.
 5. Modifications to the information and routings of the selected components shown on the electronic drawing files may be required and are the responsibility of the Contractor. All modifications are part of the scope of Work of this Project and shall be provided at no additional cost to Owner.
 6. Contractor and subcontractors agree that electronic drawing files are not fit for any particular purpose, including, but not limited to quantity take-offs, pricing, development of a building information model (BIM), clash detection, construction sequencing, or the manufacture of any building component or system.
 7. There are no assurances that the electronic drawing files will be usable by the Contractor's and subcontractors' systems, infrastructure, or software; and that the files may be subject to anomalies, errors, viruses, malware, or other unintended defects.
- C. Limitations of Electronic Drawing File Transfer Agreement:
1. Agreement Form applies to Architectural Drawings only. If Contractor desires electronic drawing files for Drawings prepared by one of Architect's consultants, Contractor may contact consultant directly to obtain such files.
 2. Contractor shall recognize that various consultants retained by the Architect for this

Project, or retained separately by the Owner, may have agreements that differ from that included in Appendix A, and may have differing costs and procedures involved with obtaining electronic drawing files.

3. Architect makes no assertion that the Architect's or Owner's consultants will furnish electronic files of their Drawings. Additionally, not all Drawings may be available electronically.

1.4 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
 1. Contractor shall become familiar with submittal requirements specified in Division 01 and in each discipline's documents to develop a complete schedule of submittals as described in Division 01 Section 32 00.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal.
 1. Initial Review: Allow 15 calendar days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Concurrent Review: Where concurrent review of submittals by Architect's consultants, Owner, or other parties is required, allow 15 calendar days for initial review of each submittal.
 3. If intermediate submittal is necessary, process it in same manner as initial submittal.
 4. Allow 15 calendar days for processing each resubmittal.
 5. Unless otherwise indicated, where any action or submittal falls due on a Saturday, Sunday, or legal holiday, such action or submittal shall be considered due on the next business day which is not a Saturday, Sunday or a legal holiday.
 6. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- D. Identification: Place a permanent label or title block on each submittal for identification.
 1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 4 X 5 inches (100 by 125 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name
 - b. Date
 - c. Name and address of Architect
 - d. Name and address of Contractor
 - e. Name and address of subcontractor
 - f. Name and address of supplier

- g. Name of manufacturer
 - h. Unique identifier, including revision number
 - i. Number and title of appropriate Specification Section
 - j. Drawing number and detail references, as appropriate
 - k. Other necessary identification.
- E. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals. Provide accompanying detailed written explanation for deviation.
- F. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.
- 1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
 - 2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.
- G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using approved transmittal form which is attached. Architect will return submittals, without review received from sources other than Contractor.
- 1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
 - 2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
 - 3. Transmittal Form: Sample form included in Appendix C at end of Section. Final Submittal format to be approved by Owner.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Use only final submittals with mark indicating "Approved" or "Approved as Noted" action taken by Architect in connection with construction.

PART 2 PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
- 1. Number of Copies:
 - a. Submit four copies of each submittal, unless otherwise indicated. Architect will retain one copy and return three copies. Mark up and retain one returned copy as a Project Record Document. Copies shall be distributed as follows:
 - 1) One copy for Contractor's use.
 - 2) One copy for subcontractor's use.
 - 3) One copy shall be provided to the Owner. Furnish Owner with final copy designated as "Approved" or "Approved as Noted" only.
 - 4) Contractor shall be responsible for providing additional copies as required for additional personnel, field use, etc.
 - b. Submit one extra set of submittals to be retained by Architect's consultant, where the consultant was delegated design responsibility for that item of work to which submittal pertains.

- c. Submit one extra set of applicable Division 23 related submittals for Commissioning of HVAC system.
 2. Surplus copies in addition to those indicated above will not be marked up by the Architect or consultant.
 - B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable. Submittals not clearly identifying which products and options are being proposed will be returned without action.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations
 - b. Manufacturer's product specifications
 - c. Standard color charts
 - d. Manufacturer's catalog cuts
 - e. Wiring diagrams showing factory-installed wiring
 - f. Compliance with recognized trade association standards
 - g. Compliance with recognized testing agency standards
 - h. Application of testing agency labels and seals
 - i. Notation of coordination requirements
 - C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 1. Submittals containing reproduction of Contract Drawings are not considered Shop Drawings and will be returned without action. Any delay due to such rejection will not be grounds for an extension of Contract Time.
 2. Preparation: Include the following information, as applicable:
 - a. Dimensions
 - b. Identification of products
 - c. Fabrication and installation drawings
 - d. Roughing-in and setting diagrams
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring
 - f. Templates and patterns
 - g. Schedules
 - h. Design calculations
 - i. Compliance with specified standards
 - j. Notation of coordination requirements
 - k. Notation of dimensions established by field measurement
 3. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 4. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches(215 by 280 mm) but no larger than 30 by 42 inches (750 by 1050 mm).
 5. Number of Copies: Submit one correctable, translucent, reproducible print and three opaque prints of each submittal. Architect will return the marked-up reproducible print and two opaque prints for Contractor to make copies and distribute.
 - D. Samples: Prepare physical units of materials or products, including the following:
 1. Comply with requirements in Division 01 Section "Quality Assurance Requirements" for mockups.
 2. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

- a. Submit color charts showing actual colors (photographic representations or reproductions will not be accepted).
 3. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 4. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Architect's sample where so indicated. Attach label on unexposed side that includes the following:
 - a. Generic description of Sample
 - b. Product name or name of manufacturer
 - c. Sample source
 5. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:
 - a. Size limitations
 - b. Compliance with recognized standards
 - c. Availability
 - d. Delivery time
 6. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
 - a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least three sets of paired units that show approximate limits of the variations.
 - b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, and details of assembly, connections, operation, and similar construction characteristics.
 7. Number of Samples for Initial Selection: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
 8. Number of Samples for Verification: Submit three sets of Samples. Architect will retain two sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project Record Sample.
 - a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 9. Coordinate with Architect for location of sample delivery to Architect's office or to Project site.
 10. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- E. Product Schedule or List: Prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product.
 2. Number and name of room or space.
 3. Location within room or space.

- F. Submittals Schedule: Comply with requirements in Division 01, Section "Construction Progress Documentation."
- G. Application for Payment: Comply with requirements in Division 01, Section "Payment Procedures."
- H. Schedule of Values: Comply with requirements in Division 01, Section "Payment Procedures."
- I. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A (see attached Appendix B). Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 - 1. Number of Copies:
 - a. Submit two copies of each submittal, unless otherwise indicated. Architect will not return copies.
 - b. Submit one extra set of applicable Division 23 and other mechanical controls-related submittals for commissioning of HVAC System.
 - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification.
 - a. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - 3. Test and Inspection Reports: Comply with requirements in Division 01 Section "Quality Assurance Requirements."
- B. Coordination Drawings: Refer to Division 01 Section 31 06.
- C. Contractor's Construction Schedule: Comply with requirements in Division 01, Section "Construction Progress Documentation."
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Certificates:
 - 1. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
 - 2. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.
 - 3. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
 - 4. Product Certificates: Prepare written statements on manufacturer's letterhead

- certifying that product complies with requirements.
5. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.
- F. Test Reports:
1. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
 2. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
 3. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.
 4. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
 5. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.
- G. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 01 Section "Closeout Procedures."
- H. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
1. Preparation of substrates
 2. Required substrate tolerances
 3. Sequence of installation or erection
 4. Required installation tolerances
 5. Required adjustments
 6. Recommendations for cleaning and protection
- I. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.

6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.
- J. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- K. Construction Photographs: Comply with requirements in Division 01 Section "Construction Progress Documentation."
- L. Material Safety Data Sheets: Not a required submittal, nor subject to Architect's review or approval, since Contractor remains solely responsible for job site safety controls, procedures, and programs. Submit information directly to Owner as part of Closeout Submittals unless otherwise directed.
 1. If submitted to Architect, Architect will not review this information and will return it with no action taken.

2.3 DELEGATED DESIGN

- A. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- B. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- C. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
 1. Ensure submittal is specifically required by the Contract Documents. Submittals not required shall not be submitted and will not be processed or reviewed by the Architect.
 2. Verify:
 - a. Field measurements
 - b. Field construction criteria
 - c. Catalog numbers and similar data
 - d. Proper interface with adjacent or related work
 3. Coordinate each submittal with requirements of Work of Contract Documents

4. Assign submittal number in accordance with the following:
 - a. Six-digit Specification Section number
 - b. Two-digit number representing product, material, or item in referenced Section to which submittal pertains (01, 02, 03, 04, etc.).
 - c. Single letter representing submittal sequence ("A" for initial submittal, "B" for first re-submittal, "C" for second re-submittal, etc.).
 5. Each specified material, product, or item shall be submitted individually, as a separate, uniquely identified submittal. Assembled booklets containing multiple products or systems will not be permitted, and will be returned without action.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
1. Language on Contractor's submittal review stamp shall be consistent with the requirements of the Agreement and General Conditions.
 2. A stamp containing language which defers or assigns Contractor's responsibilities to subcontractor will not be permitted; submittals bearing a stamp with such language will be returned without action. Any delay due to such rejection will not be grounds for an extension of Contract Time.

3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 1. Approved
 2. Approved as Noted
 3. Revise and Resubmit
 4. Not Approved
 5. No Action Required by Architect
- C. Informational Submittals: Architect will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION

01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.

1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
 - 2. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance

with specified criteria.

- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

1.3 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.5 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.

2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.6 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
 3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.

4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and re-inspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.8 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.
 - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed unless otherwise indicated.
- L. Integrated Exterior Mockups: Refer to Section 01 43 39 "Mockups" for requirements.
- M. Room Mockups: Refer to Section 01 43 39 "Mockups" for requirements.
- N. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.9 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
 - 3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 - 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

- C. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- D. **Manufacturer's Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. **Retesting/Re-inspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. **Testing Agency Responsibilities:** Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of Contractor.
- G. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. **Schedule of Tests and Inspections:** Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.10 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
 1. Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 2. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
 3. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies?
 4. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 5. Retesting and re-inspecting corrected work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Division 01 Section "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 01 45 23

TESTING AND INSPECTING SERVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements and qualifications including but not limited to:
 - 1. Professional testing and laboratory services.
 - 2. Accessories necessary for the completion of testing and laboratory services.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and quality control procedures that facilitate compliance with Contract Document requirements.
 - 3. Requirements for Contractor to provide quality assurance and quality control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions.
 - 4. Specific test and inspection requirements are not specified in this Section.
- C. A qualified independent testing laboratory and/or geotechnical engineering service selected and paid by Owner.
 - 1. The Owner will pay for the initial laboratory services of materials that comply with the requirements of the Contract Documents. The Contractor shall pay for testing and retesting of materials that do not comply with the requirements of the Contract Documents.
- D. Inspecting agency shall perform inspections and tests in accordance with the rules and regulations of the building code, local authorities, Specifications of ASTM, and the Contract Documents.
- E. Materials and workmanship found not in compliance with required standards or performance obligations shall be removed and replaced. Replacement and subsequent testing shall be at Contractor's expense.
- F. Where terms "Inspector" and "Laboratory" are used, it is meant and in reference to an officially designated and accredited inspector of the testing laboratory or geotechnical service engaged by Owner.
- G. Laboratory inspections shall not relieve the Contractor or Fabricator of his responsibility to furnish materials and workmanship in accordance with the Contract Documents.

- H. Contractor or Fabricator shall cooperate with the testing laboratory in matters pertaining to the Work.
- I. Contractor to address deficiency and failed reports.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, documented according to ASTM E 329 and ASTM E534; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
 - 3. Testing agencies shall be insured against errors and omissions by a professional liability insurance policy having a minimum limit of liability of \$500,000.00.
- B. Inspection and testing services the of testing agency shall be under the direction of a Registered Engineer licensed in the State of Texas, charged with engineering managerial responsibility, and having a minimum of five (5) years engineering experience in inspection and testing of construction materials.
- C. Concrete Inspectors: Inspecting personnel monitoring concrete Work shall be ACI certified inspectors.
- D. Structural Steel: Primary inspectors performing structural steel inspection shall be currently certified AWS Certified Welding Inspectors (CWI), in accordance with the provisions of AWS QCI, *Standard and Guide for Qualification and Certification of Welding Inspectors*.
 - 1. Inspector may be supported by assistant inspectors who perform specific inspection functions under the direct supervision of the Primary Inspector. Assistant inspectors shall be currently certified AWS Certified Associate Welding Inspectors (CAWI). Work of assistant inspectors shall be monitored daily by the inspector.
- E. Testing Equipment: Equipment shall be calibrated at intervals not exceeding 12 months by devices of accuracy traceable to the National Bureau of Standards.
- F. Referenced Standards: Latest adopted edition of standards referenced apply to the Work. In the event of conflict between the Contract Documents and referenced standards, the Contract Documents shall govern. In case of conflict between Contract Documents and the Building Code, the more stringent shall govern.

1.4 QUALITY CONTROL

- A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform the services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

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- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with requirements, whether specified or not.
1. Refer to the individual specification sections for specific requirements.
 2. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of Contractor by authorities having jurisdiction, whether specified or not.
 3. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform the quality control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 4. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 5. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.
 6. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 7. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
 8. Associated Responsibilities and Services: Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - a. Provide access to the Work.
 - b. Deliver of samples to testing laboratory, without cost to Owner, in adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - c. Advise laboratory and Architect sufficiently in advance of construction operations to allow laboratory to complete required inspections or tests and to assign personnel for field inspection and testing as specified.
 - d. Provide facilities for storage and curing of concrete test samples on site for the first 24 hours and for subsequent field curing required by ASTM C31.
 - e. Incidental labor, facilities, and equipment necessary to assist laboratory personnel in obtaining and handling samples at the site.
 - f. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - g. Provide concrete mix designs in accordance with ACI 301 Section 3.9 made by an independent testing laboratory or qualified concrete supplier. Where mix designs by an independent testing laboratory are required, select and pay for laboratory.
 - h. Obtain required inspections or approvals of the building official. Inspection requests and notifications required by building code are responsibility of the Contractor.
 - i. Provide current welder certificates for each welder employed.
 - j. Provide fabrication and erection inspection and testing of welds in accordance with AWS D1.1, Chapter 6.
 - 1) Use prequalification of welding procedures in executing the Work.
 - k. Security and protection for samples and for testing and inspecting equipment at Project site.
 9. Retesting/Reinspecting: Regardless of payment responsibility of the original tests or inspections, provide quality control services, including retesting and reinspecting, for construction that replaced Work failing to comply with the Contract Documents or Code requirements.
- C. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- D. Coordination: Coordinate sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.5 AUTHORITY AND DUTIES OF LABORATORY PERSONNEL

- A. A representative of the testing laboratory, who has reviewed and is familiar with the project and specifications, shall participate in preconstruction conferences. The representative shall coordinate material testing and inspection requirements with the Contractor and its subcontractors consistent with the planned construction schedule. The laboratory representative shall attend conferences required or requested to address quality control issues.
- B. Laboratory personnel shall inspect and test materials, assemblies, specimens, and Work performed, including design mixes, methods and techniques and report the progress to the Architect.
- C. If material or Work fails to meet requirements of Contract Documents, laboratory inspector shall notify the Construction Manager, Architect, Engineers, supplier or subcontractor providing or preparing the materials or Work being tested of such failure.
- D. Laboratory personnel shall not perform the Work of the Contractor or act as foremen or superintendents. Work will be inspected as it progresses, but failure to detect defective Work or materials shall not prevent later rejection when a defect is discovered.
- E. Laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release the requirements of the Contract Documents or approve or accept portions of Work, except where approval is specifically specified in the Specifications.
- F. Comply with building code requirements for Special Inspections.

1.6 SUBMITTALS

- A. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
- B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
1. Specification Section number and title.
 2. Entity responsible for performing tests and inspections.
 3. Description of test and inspection.
 4. Identification of applicable standards.

5. Identification of test and inspection methods.
 6. Number of tests and inspections required.
 7. Time schedule or time span for tests and inspections.
 8. Requirements for obtaining samples.
 9. Unique characteristics of each quality control service.
- C. Test and Inspection Reports: Prepare and submit certified written reports specified. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- D. Submit copies of reports of each inspection and test:
1. Owner, Program or Project Manager, Architect, and each Engineer or outside consultants regarding their particular phase of the project: One copy each.
 2. Construction Manager and Contractor: Two copies each.
- E. In addition to furnishing a written report, notify Construction Manager and Contractor verbally of uncorrected conditions or failures to comply with requirements of the Contract Documents, and immediately fax and email corresponding report to the Architect and Engineer.
- F. At completion of each trade or branch of Work requiring inspecting and testing, submit a final certificate attesting to satisfactory completion of Work and full compliance with requirements of Contract Documents.
- G. Submit copies of test results sealed by a Registered Engineer to municipal authorities having jurisdiction, as required.

1.7 TESTING LABORATORY GUIDELINES AND PROCEDURES

- A. Technicians scheduled to perform specific testing services must be qualified to review and perform other services that overlap, i.e. earthwork, foundation inspections, rebar inspection, and concrete when scheduled concurrently at the site.
- B. Technician time for services performed will be reimbursed at a regular time rate. Compensation at the overtime rate will be considered for hours over eight hours spent at the site on a single day, field testing services performed on a Saturday or Sunday, and field services performed on a recognized holiday.
- C. There shall be a three hour minimum for each scheduled testing service. Vehicle charges will be included on a \$25.00 per trip basis.

- D. Cylinder pick up will be controlled by the technician performing test on a scheduled pick up day. If there are no testing services scheduled, the cylinder pick up fee is \$40.00 on week days and \$50.00 on weekends and holidays with no technician or vehicle charge.
- E. The Contractor shall bear the responsibility of scheduling the testing services. The Contractor and the testing laboratory shall assume full responsibility to coordinate the testing services. Cancellations or failed test shall be reimbursable to the Owner by the responsible party for the cancellations or failure of a test or service.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Architect.
 - 4. Identification of testing agency or special inspector conducting test or inspection.
 - 5. Deficiency log.
- B. Maintain log at site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 TESTING AND INSPECTION SERVICES

- A. Testing services shall include, but not be limited to those specified below or which are necessary or required during course of construction to ascertain specification compliance and which may be deemed necessary by Architect, Engineer, or Owner to ensure the quality of the Work.
- B. The Owner reserves the right to add to or delete any or all inspection and testing specified, excluding testing required by the applicable building codes.
- C. If conflicts arise between Drawings and Specifications, notify Architect immediately. The most stringent requirements shall dictate procedure.

3.3 TESTING OF EARTHWORK

- A. Testing Services (As specified or required):
 - 1. References (As applicable for tests required):
 - a. American Society for Testing and Materials (ASTM)
 - 1) D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³))
 - 2) D2922, Standard Test Method for Density of Soil and Soil-Aggregate In Place By Nuclear Methods (Shallow Depth)
 - 3) D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 - b. American Association of State Highway and Transportation Officials (AASHTO)
 - 1) T89, Determining the Liquid Limit of Soils
 - 2) T90, Determining the Plastic Limit and Plasticity Index of Soils

- 3) T99, Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305-mm (12-in) Drop
 - 4) T238, Density of Soil and Soil Aggregates In Place By Nuclear Methods (Shallow Depth)
2. Perform sieve analysis to develop grain size distribution curves for materials to be used for subgrade, fill under slab on grade, and backfills.
 3. Establish the moisture density relation of soils to be used as fill using the method best suited to the type of fill material.
 4. Determine moisture content of all fill materials before placement and advise Contractor when it is or is not suitable to achieve required compaction.
 5. Determine Liquid Limit in accordance with ASTM D4318 or AASHTO T89, Plastic Limit in accordance with ASTM D4318, and Plasticity Index in accordance with ASTM D4318 of all fill material,
 6. Perform one in place density test for each 2,500 square feet (280 square yards) of existing subgrade material.
 7. Perform Moisture-Density curve in accordance with ASTM D698 or AASHTO T99 for one type of fill material. If the original choice of material does not meet the specifications, the Contractor shall pay for additional testing.
 8. Perform in place density tests of each lift of compacted fill at locations adequate to evaluate the degree of compaction of all fill areas. Conduct one test for each 2,500 square feet (280 square yards) of each lift of compacted fill.
 9. Perform testing at a frequency of one in-place density and moisture test for each 75 lineal feet or less of utility trench, with a minimum of three tests per lift

B. Reports: Submit reports with the following information:

1. Type and condition of soil at footing bottoms.
2. Level of water table in the excavated areas.
3. Grain size distribution of fill materials (average of three tests).
4. Moisture density test results.
5. In place density test results with moisture content and relative density of each layer of compacted fill. Include with in place density test results, a plan showing location of each test.
6. Notify Architect by telephone within one hour of the discovery of the following conditions and follow up telephone notification with written report.
 - a. Materials used, or degree of soil compaction not meeting specified requirements.
 - b. Frost and freeze protection requirements for excavation bottoms not being complied with.
 - c. Water in excavations which is not being removed prior to Work being performed in excavation.

3.4 INSPECTION OF PIPED SITE UTILITIES

A. Laboratory representative shall observe and report on the following:

1. Proper alignment and grade of trenches.
2. Pipe bedding and supports.
3. Pipe, joints, jointing material, and thrust blocks prior to installation of pipe.
4. Installation of pipe and joints.
5. Testing of piped utilities performed by Contractor.

3.5 PAVING

A. Testing Services: Perform field tests for moisture density properties:

1. Provide field testing of the subgrade as specified.

2. Paving Subbase: Provide one field test for every 5,000 square feet of area of crushed limestone or caliche subbase.
3. Lime Treated Subgrade: Provide one field test for every 5,000 square feet of area of lime treated subgrade for content of lime and subgrade compaction.
4. Cement Soil Stabilization: Provide one field test for every 5,000 square feet of area of cement stabilized subgrade for content of cement and subgrade compaction.

3.6 PIER DRILLING OPERATION

- A. A representative of a qualified geotechnical laboratory shall provide services specified.
- B. Laboratory representative shall make continuous inspections to determine that proper bearing stratum is obtained and utilized for bearing and that shafts are properly clean and dry before placing concrete.
- C. Laboratory shall furnish complete pier log showing the diameter, top and bottom elevations of each pier, casing required or not required, actual penetration into bearing stratum, elevation of top of bearing stratum, volume of concrete used, and deviations from specified tolerances.
- D. Laboratory representative shall make continuous inspections of drilled pier construction to check the following:
 1. Verify soundness of bearing stratum and desired penetration.
 2. Verify pier dimensions and reinforcing used.
 3. Monitor condition of hole and removal of water and loose material from bottom.
 4. Monitor placement of concrete and use of tremie or pumps.
 5. Monitor the extraction of casing, if used.
- E. Request probe holes when deemed necessary to confirm safe bearing capacity.

3.7 CONCRETE REINFORCING STEEL AND EMBEDDED METAL ASSEMBLIES

- A. Inspect concrete reinforcing steel prior to placing concrete for compliance with Contract Documents and approved shop drawings. Noncompliance with Contract Documents and approved shop drawings shall be immediately brought to the attention of the Contractor for correction and, if left uncorrected, reported to the Architect.
- B. Laboratory representative shall observe and report on the following:
 1. Number and size of bars.
 2. Bending and lengths of bars.
 3. Splicing.
 4. Clearance to forms, including chair heights.
 5. Clearance to sides and bottom of trench if soil formed.
 6. Clearance between bars or spacing.
 7. Rust, form oil, and other contamination.
 8. Grade of steel.
 9. Securing, tying, and chairing of bars.
 10. Excessive congestion of reinforcing steel.
 11. Installation of anchor bolts and placement of concrete around such bolts.
 12. Fabrication and installation of embedded metal assemblies, including visual inspection of all welds.
 13. Visually inspect studs and deformed bar anchors on embedded assemblies for compliance with Contract Documents. Check number, spacing and weld quality. If, after welding, visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained for a particular stud or bar, such stud or bar shall be struck with a hammer

and bent 15 degrees off perpendicular and then bent back into position. Anchors failing this test shall be replaced.

- C. Provide a qualified, experienced inspector to inspect reinforcing steel. Inspector shall have a minimum of three years experience inspecting reinforcing steel in projects of similar size.

3.8 CONCRETE INSPECTION AND TESTING

- A. Receive and evaluate proposed concrete mix designs submitted by Contractor. If mix designs comply with Drawings and Specifications, the laboratory shall submit a letter to the Architect certifying compliance. Mix designs not complying with Drawings and Specifications shall be returned by the laboratory as being unacceptable. Check the proposed mixes for proportions, water cement ratio and slump in accordance with ACI 613 and 318.
- B. Comply with ACI 311 *Guide For Concrete Inspection* and ACI *Manual of Concrete Inspection* (SP-2).
- C. Sample and test concrete placed at the site in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis.
- D. Test concrete:
 - 1. Mold and cure five specimens from each sample.
 - a. For each 50 cubic yards or fraction thereof of structural building concrete; and
 - b. For each 100 cubic yards or fraction thereof of nonstructural concrete and site Work paving and sidewalks.
 - c. Laboratory cure two cylinders in accordance with ASTM C192.
 - d. Field cure remaining cylinders in accordance with ASTM C31.
 - 2. Two specimens shall be tested at seven days for information, two shall be tested at 28 days for acceptance.
 - 3. Store one cylinder for testing at 56 days in the event the 28 days strength tests do not meet strength requirements.
- E. Deviations from the requirements of ASTM Specifications shall be recorded in the test report. Test concrete specimens in accordance with ASTM C39.
- F. Specimens for pumped concrete shall be taken at the discharge end of pumping equipment.
- G. Supervise curing and protection provided for test specimens in field, and transportation from the field to laboratory. Test cylinders shall be stored in the field 24 hours and then carefully transported to laboratory and cured in accordance with ASTM C31.
- H. Make one strength test (four cylinders) of each mix design of concrete placed in any one day.
- I. Make one slump test for each set of cylinders following procedural requirements of ASTM C143 and ASTM C172. Make additional slump tests whenever consistency of concrete appears to vary. Slump tests corresponding to samples from which strength tests are made shall be reported with strength test results. Other slump tests need not be reported.
- J. Determine total air content of air entrained normal weight concrete sample for each strength test in accordance with ASTM C231.
- K. Determine air content and unit weight of lightweight concrete sample for each strength test in accordance with ASTM C173 and ASTM C567.

- L. Determine temperature of concrete sample for each strength test.
- M. Inspect each batch of concrete, monitor addition of mixing water to assure uniform consistency from truck to truck. Check mixing form mixers before mix begins to set and within time limits set forth in ASTM C94.
 - 1. Monitor addition of water and high range water reducer to concrete at job site and length of time concrete is allowed to remain in truck during placement.
- N. Testing agency shall furnish and maintain a competent inspector at the mixing plant at the start of each day's mixing. Inspector shall examine concrete materials for compliance with Specifications and approved mix design, weighing and measuring devices, proportioning and mixing of materials, water and cement content of each batch, general operation of the plant, and transportation of concrete to jobsite. Inspector shall verify that amount of free surface moisture contained in fine and course aggregate has been properly accounted for in the concrete mixing to achieve required consistency and water cement ratio.
- O. Testing laboratory shall monitor addition of water to concrete at the jobsite and the length of time concrete is allowed to remain in the truck before placement. Inspector shall compare mixture with criteria on the approved mix design and report any significant deviation to the Architect, Contractor and concrete supplier. Do not permit addition of water which will exceed maximum water/cement ratio for the mix as given on the approved mix design.
- P. Observe placing of concrete, except nonstructural slabs on grade and site Work. Observe and report on placing method, consolidation, cold joints, length of drop, and displacement of reinforcement. Report deficiencies to Contractor immediately for corrective action. Inspections may be reduced to a periodic basis when all procedures have been deemed satisfactory by the laboratory.
- Q. Test reports shall include but no be limited to the following information: date of concrete placement, concrete mix identification number or proportion of ingredients, truck ticket number, time test was made, time of batching, location of each placement, slump, unit weight, water content (microwave test) and air content of concrete sampled and date and results of strength test.
- R. Report promptly to Architect all details of reasons for rejection of any and all quantities of concrete. Give all information concerning locations of the concrete pours, quantities, date of pours, and other pertinent facts concerning concrete represented by the specimens.
- S. Testing laboratory shall certify each delivery ticket indicating class of concrete delivered (or placed), amount of water added and time at which cement and aggregate were dispensed into the truck, and time at which concrete was discharged from the truck.
- T. Evaluation and Acceptance:
 - 1. If measured slump, or air content of air entrained concrete, falls outside specified limits, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, concrete shall be considered to have failed to meet the requirements of the specifications, and shall not be used in the structure.
 - 2. Strength level of concrete will be considered satisfactory if the averages of sets of three consecutive strength tests results are equal to, or exceed, specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.
 - 3. Completed concrete Work will be accepted when requirements of ACI 301 Chapter 18 *Specifications for Structural Concrete for Buildings* have been met.

- U. Concrete Test Reports: Reports shall be made and distributed immediately after respective tests or inspections are made.
 - 1. Where reports indicate deviations from Contract Documents, they shall also include a determination of the probable cause of deviation and where applicable, a recommendation for corrective action.

- V. Furnish a statistical analysis for each class of concrete placed on the project in accordance with ACI 214 and ACI 318. Information shall be updated and distributed once a month as directed by the Architect. Information shall include, but not be limited to, the following:
 - 1. Strength tests at seven days.
 - 2. Strength tests at 28 days of two cylinder averages.
 - 3. 28 day moving average strength tests of last three test groups.
 - 4. Standard deviation and coefficient of variation based on 28 day strength tests.
 - 5. Average strength and number of 28 days tests for most recent month.
 - 6. Strength test one cylinder at 56 days in the event the 28 days strength tests do not meet strength requirements.

- W. Test Footings (Shafts) (Piers) (Caissons): Same diameter and type specified for footings, placed in same manner. Accepted test footings may be used in the Work.

- X. Noncompliant Test Reports: Fax test reports indicating noncompliance immediately to each party on the test report distribution list. Copies shall be on different colored paper.

- Y. Inspect application of curing compound and monitor curing conditions to assure compliance with specification requirements. Report curing deficiencies to the Contractor immediately and submit a written report to the Architect.

3.9 TESTING OF NONSHRINK GROUT

- A. Make one strength test for all plates grouted and for all grout used in joints between members.

- B. Each test shall consist of four cubes, two tested at 7 days and two at 28 days, made and tested in accordance with ASTM C109, with the exception that grout shall be restrained from expansion by a top plate.

3.10 STRUCTURAL STEEL

- A. Inspect structural steel during and after erection for compliance with Contract Documents and shop drawings. Review and report on fabricator's quality control procedures and capabilities.

- B. Field Inspection:
 - 1. Proper erection of pieces.
 - 2. Proper touch up painting of shop primed structural steel exposed to view or in crawl space.
 - 3. Proper installation of bolts.
 - 4. Plumbness of structure and proper bracing.
 - 5. Proper field painting.
 - 6. Initial inspection of welding process and periodically thereafter as necessary.
 - 7. Visual examination of completed welds.
 - 8. Ultrasonic testing of penetration field welds.
 - 9. Installation of field welded shear studs.
 - 10. Inspect shop fabricated members, upon arrival at the site, for defects incurred during transit and handling.

11. Measure and record camber of beams upon arrival and before erection for compliance with specified camber. Measure lying flat with web horizontal. Return members outside specified camber tolerance to shop for correction.
- C. Qualifications of Welders: Fabricator and erector shall provide the testing laboratory with names of welders employed on Work, along with certification that each welder has passed qualification tests within the past 12 months, using procedures covered in AWS D1.1 *Structural Welding Code - Steel*. Verify welder qualifications.
- D. Inspection of field welding shall include:
1. Visually inspect fillet welds for size, soundness, and proper return around ends. Inspect seams, folds, and delaminations.
 2. Visually inspect welds for proper repair of painting.
 3. Ultrasonically test penetration welds in accordance with ASTM E164.
 4. Inspect surfaces to be welded. Note surface preparations, fit up, and cleanliness of surface. Verify electrodes for size, type, and condition.
 5. Welding inspector shall be present during alignment and fit up of members being welded, and shall verify for correct surface preparation of root openings, sound weld metal, and proper penetration in the root pass. Where weld has not penetrated completely, inspector shall order the joint to be chipped down to sound metal, or gouged out, and rewelded. Thoroughly inspect root passes for cracks. Gouge out cracks and rewelded to 2 inches beyond each end of crack.
 6. Inspector shall verify that welds have been marked with welder's symbol and shall mark welds requiring repairs and reinspection. Inspector shall maintain a written record of welds. Work completed and inspected shall receive an identification mark by the inspector. Identify unacceptable material and Work identified by word *reject* or *repair* marked directly on the material.
 7. Testing agency shall advise the Owner and Architect of any shop and/or field conditions which may require further tests and examination by means other than those specified. Additional tests and examinations shall be performed as authorized by the Owner and Architect.
 8. Owner reserves the right to use ultrasonic or radiographic inspection to verify adequacy of welds. Testing procedures and acceptance criteria shall be as specified in AWS D1.1.
 9. Weld quality to comply with the American Institute of Steel Construction (AISC) Manual of Steel Construction.
 10. Determine percentage of weld tested by the number of welds that fail the initial testing.
 11. Reweld and retest welds that fail until the welds pass. Test two additional welds for every weld failure.
- E. Inspect bolted construction in accordance with AISC *Specification for Structural Steel Buildings*:
1. Visually inspect bolts ensuring that plies have been brought into snug contact.
 2. Inspect high strength bolt in accordance with Section 9 of the *Specifications for Structural Joints Using ASTM A325 or A490 Bolts*.
- F. Inspect stud welding in accordance with Section 7.8, of AWS D1.1 *Structural Welding Code*:
1. Weld at least two shear studs at the start of each production period to determine correct generator, control unit, and stud welder setting. The studs shall be capable of being bent 45 degrees from vertical without weld failure.
 2. When the temperature is below 32 degrees F (0 degrees C), test one stud in each 100 after cooling. Do not weld studs at temperatures below 0 degrees F or when surface is wet with rain or snow. If stud fails in the weld, two new studs shall pass the test before resumption of welding.
 3. Visually inspect studs for compliance with the requirements of the Contract Documents. Verify number, spacing, and weld quality. If, after welding, visual inspection reveals that

a sound weld or a full 360 degree fillet has not been obtained for a particular stud, that stud shall be struck with a hammer and bent 15 degrees off perpendicular in the direction away from the missing weld. Studs failing test shall be replaced.

3.11 REINFORCING STEEL MECHANICAL SPLICES

- A. Inspection and Observation Services:
 - 1. Visually inspect and report on completed condition of each mechanical splice of reinforcing steel.
 - 2. Visually inspect each mechanical splice to ensure compliance with the ICC-ES Reports and the manufacturer's published criteria for acceptable completed splices.
 - 3. Place special emphasis on the inspection of the end preparation of each bar to be spliced required by the ICC-ES Report.
- B. Reports: Submit reports to Architect:
 - 1. Submit copies of manufacturer's published criteria for acceptable completed splices prior to observing mechanical splices.
 - 2. Reports on each mechanical splice shall indicate location of the splice, size of bars spliced, and acceptability or rejection of splice. Indicate reasons for rejection on each report.

3.12 OPEN WEB JOISTS AND JOIST GIRDERS

- A. Inspect joists at jobsite for compliance with specified fabrication requirements. Verify welded connections between web and chord, splices, and straightness of members.
- B. Inspect installation of joists at jobsite. Check connections to supporting members, chord extensions, number of rows of bridging, and bridging connections for compliance with Contract Documents and referenced standards.
- C. Verify welder qualification certificates for both shop and field welding operators.

3.13 METAL FLOOR DECK

- A. Field inspection shall consist of:
 - 1. Verifying types, gauges and finishes for compliance with Contract Documents and shop drawings.
 - 2. Examine composite floor deck exposed to crawl space for damage to galvanizing due to welding or construction activities. Repair galvanized composite floor deck in accordance with the specifications.
 - 3. Examine the erection of metal deck, fastenings, reinforcing of holes, deck reinforcing, miscellaneous deck supports, hanger tabs, shear studs, deck closures, painting or other coating.
 - 4. Certification of welders.
 - 5. Inspect and test field welded shear studs used to fasten metal floor decking to supporting steel as specified for structural steel.

3.14 METAL ROOF DECK

- A. Field inspection shall consist of:
 - 1. Verify types, gauges and finishes for compliance with Contract Documents and shop drawings.
 - 2. Examine the erection of the metal deck, including fastenings at supports and side laps, reinforcing of holes, and miscellaneous deck supports.

3. Certification of welders.
4. Visual inspection of at least 25 percent of welds.

3.15 SPRAYED FIREPROOFING

- A. Verify applied thickness, density, and bond strength of sprayed fireproofing meets fire rating requirements of approved design.
- B. Verify installation complies with fire rating requirements of approved design.
- C. Inspect and test for thickness:
 1. Test 25 percent of structural frame columns and beams in each building level.
 2. Test 10 percent of beams other than structural frame in each building level.
 3. Test one slab per 5,000 square feet of building area.
- D. Inspect and test in accordance procedures of ASTM E605 and ASTM E736.

3.16 EXPANSION BOLT INSTALLATION

- A. Inspect drilling of each hole and installation of each expansion bolt for compliance with Contract Documents and shop drawings.
- B. Verify installation torque for each expansion bolt for compliance with manufacturer's installation instructions.

3.17 LIGHTWEIGHT INSULATING CONCRETE FILL

- A. Inspection and Observation Services (As required):
 1. Inspection of roof deck prior to start of Work.
 2. Inspection during installation of insulation and lightweight insulating concrete fill Work to ascertain compliance with Contract Documents.
 3. Observation of base ply fastener pull tests performed by Contractor to ascertain minimum withdrawal resistance of 40 pounds per fastener.
- B. Testing Services (As required):
 1. References (As applicable for tests required):
 - a. American Society for Testing and Materials (ASTM)
 - 1) C177, Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties By Means of the Guarded Hot Plate Apparatus
 - 2) C495, Test Method for Compressive Strength of Lightweight Insulating Concrete
 - 3) C578, Specification for Rigid, Cellular Polystyrene Thermal Insulation
 2. Test EPS insulation board for thermal insulation value in accordance with ASTM C177.
 3. Test lightweight insulating concrete fill in accordance with ASTM C495 for:
 - a. Mix design compressive strength.
 - b. Mix design wet and dry density range.
 - c. Number of Tests:
 - 1) One per 5,000 square feet
 - 2) Not less than one for each day's Work
 4. Test EPS insulation board for density in accordance with ASTM C578.

3.18 TESTING OF ROOFING

- A. Inspection and Observation Services (As required):
 - 1. Inspection of roof deck prior to start of Work.
 - 2. Inspect on site condition of stored roofing materials.
 - 3. Inspection during roofing, roof insulation, and sheet metal Work to ascertain compliance with Contract Documents.
 - 4. Observation of roof test cuts performed by Contractor to ascertain that they are properly made.
 - 5. Observation of patching of roof test cuts to ascertain that they are properly made.

- B. Testing Services (As required):
 - 1. Perform dissection and analysis on cuts provided by Contractor to confirm number of plies, bonding of plies, weight of bitumen and softening temperature to ascertain compliance with specifications.

3.19 MASONRY

- A. Inspection and Observation Services:
 - 1. Inspection of placement of reinforcement including condition, grade, size, location, spacing, and lap splices.
 - 2. Review mortar design mixes.
 - 3. Inspection of laying, mortaring, and grouting of concrete masonry units and elements.

- B. Testing Services:
 - 1. References (As applicable for tests required):
 - a. ASTM International (ASTM)
 - 1) C140, Standard Test Methods of Sampling and Testing Concrete Masonry Units
 - 2) C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
 - 3) C1019, Standard Test Method for Sampling and Testing Grout
 - 4) E447-97, Standard Test Methods for Compressive Strength of Laboratory Constructed Masonry Prisms
 - 2. Testing of Concrete Masonry Units (CMU):
 - a. Preconstruction: Perform the following tests in accordance with ASTM C140.
 - 1) Compressive Strength
 - 2) Absorption
 - 3) Weight
 - 4) Moisture Content
 - 5) Dimensions
 - 3. Mortar Tests:
 - a. Preconstruction: Perform the following tests in accordance with ASTM C780 on each type of mortar mix used on the Project.
 - b. 28 Day Compressive Strength
 - c. Water Retention
 - d. Construction: Perform 28 day compressive strength test in accordance with ASTM C780 on each type of mortar mix used on the Project at the rate of one test per 2,000 square feet of masonry.
 - 4. Refer to and include Work for reinforcing steel specified.
 - 5. Grout Tests:

- a. Preconstruction: Perform the following tests in accordance with ASTM C1019 on each type of grout mix used on the Project.
 - 1) Slump Test
 - 2) 28 Day Compressive Strength
 - 3) Construction: Perform 28 day compressive strength test in accordance with ASTM C1019 on each type of grout mix used on the Project at the rate of one (1) test per 2,000 square feet of masonry.
 - 4) Prism Test: Perform preconstruction 28 day compressive strength test on concrete masonry walls in accordance with ASTM E447-97, Method B.

3.20 REPAIR AND PROTECTION

- A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 30.
- B. Protect construction exposed by or for quality control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

END OF SECTION

01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities. Also reference Owners Special Conditions.
- B. Support Facilities, including but not limited to the following:
 - 1. Field offices
 - 2. Storage and fabrication sheds
 - 3. Temporary roads and paving
 - 4. Traffic controls
 - 5. Parking
 - 6. Dewatering facilities and drains
 - 7. Project identification and temporary signs
 - 8. Waste disposal facilities
 - 9. Lifts and hoists
 - 10. Temporary elevator usage
 - 11. Temporary stairs
 - 12. Construction aids and miscellaneous services and facilities
- C. Temporary Utilities, including but not limited to the following:
 - 1. Sewers and drainage
 - 2. Water service and distribution
 - 3. Sanitary facilities, including toilets and drinking-water facilities
 - 4. Heating and cooling facilities
 - 5. Ventilation and humidity control
 - 6. Electric power service
 - 7. Lighting
 - 8. Telephone service
 - 9. Electronic communications service
- D. Security and Protection Facilities, including but not limited to the following:
 - 1. Environmental protection
 - 2. Storm water control
 - 3. Pest control
 - 4. Site enclosure fence
 - 5. Security enclosure and lockup
 - 6. Security cameras where required by Owner
 - 7. Barricades, warning signs, and lights
 - 8. Temporary means of egress
 - 9. Covered walkways
 - 10. Temporary enclosures
 - 11. Temporary partitions
 - 12. Temporary fire protection

- E. Related Sections include the following:
 - 1. Division 01, Section "Summary of Work" for work restrictions and limitations on utility interruptions.
 - 2. Division 01, Section "Temporary Tree and Plant Protection" for protection of trees and vegetation in work areas.
 - 3. Division 01, Section "Erosion and Sedimentation Control" for temporary measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties.

1.2 DEFINITIONS:

- A. Permanent Enclosure: As determined by Architect, includes as a minimum, the following:
 - 1. Permanent or temporary roofing is complete, insulated, and weathertight, including parapets and roof edge terminations.
 - 2. Exterior walls are insulated, weathertight, and UV-resistant.
 - 3. All openings are closed with permanent construction or substantial weathertight temporary closures.
 - 4. Permanent enclosure envelope shall be capable of retaining controlled interior temperature and humidity levels.

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction. Contractor shall be accountable for wasteful usage of Owner provided utilities.
- B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.

1.4 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage including delivery, handling, and storage provisions for materials subject to water absorption or water damage, discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged Work.
 - 1. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water and dirt from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each

temporary utility before use. Obtain required certifications and permits.

- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.
- B. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
 - 1. Keep temporary services and facilities clean and neat.
 - 2. Relocate temporary services and facilities as required by progress of the Work.
 - 3. At earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Architect. Provide materials suitable for use intended.
- B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails.
 - 1. Provide concrete or galvanized steel bases for supporting posts.
- C. Wood Enclosure Fence: Plywood, 8 feet high, framed with four 2-by-4-inch rails, with preservative-treated wood posts spaced not more than 8 feet apart.
- D. Lumber and Plywood: Comply with requirements in Division 06, Section "Miscellaneous Carpentry,"

2.2 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated with lockable entrances, operable windows, and serviceable finishes; heated and air conditioned; on foundations adequate for normal loading.
- B. Common-Use Field Office: Provide an insulated, weathertight, air-conditioned field office for use as a common facility by all personnel engaged in construction activities; of sufficient size to accommodate required office personnel and meetings of 15 persons at Project site. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Water cooler and private toilet complete with water closet, lavatory, and medicine cabinet with mirror.
 - 3. Provide a room of not less than 240 sq. ft. for Project meetings. Furnish room with conference table, 15 folding chairs, and minimum 4-foot- square tack board.
 - 4. Provide resilient floor covering, painted gypsum wallboard or wood paneled walls, and acoustical ceiling. Provide operable windows with adjustable blinds and insect

- 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 - 6. Provide fluorescent light fixtures capable of maintaining average illumination of 20 fc at desk height. Provide 110- to 120-V duplex outlets spaced at not more than 12-foot intervals, 1 per wall in each room.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility services. Sheds may be open shelters or fully enclosed spaces within building or elsewhere on-site.
- 1. Construct framing, sheathing, and siding using fire-retardant-treated lumber and plywood.
 - 2. Paint exposed lumber and plywood with exterior-grade acrylic-latex emulsion over exterior primer.

2.3 EQUIPMENT

- A. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
- 1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.
- B. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- C. Drinking-Water Fixtures: Containerized, bottled-water drinking-water units, including paper cup supply.
- 1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F .
- D. HVAC Equipment: Unless Owner authorizes use of permanent heating system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
- 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use for type of fuel being consumed.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction and clean HVAC system as required in Division 01, Section "Closeout Procedures".
- E. Electrical Outlets: Properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.
- F. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
 - 2. Provide adequate capacity at each stage of construction. Before temporary utility is available, provide trucked-in services.
 - 3. Obtain easements to bring temporary utilities to Project site where Owner's easements cannot be used for that purpose.
- B. Uninterrupted utility services to the existing facilities are imperative. Provide temporary utilities as necessary during required change over times for each utility to ensure uninterrupted service.
- C. Sewers and Drainage: If sewers are available, provide temporary connections to remove effluent that can be discharged lawfully. If sewers are not available or cannot be used, provide drainage ditches, dry wells, stabilization ponds, and similar facilities. If neither sewers nor drainage facilities can be lawfully used for discharge of effluent, provide containers to remove and dispose of effluent off-site in a lawful manner.
 - 1. Filter out excessive soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
 - 2. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. After heavy use, restore normal conditions promptly.
 - 3. Provide temporary filter beds, settlement tanks, separators, and similar devices to purify effluent to levels acceptable to authorities having jurisdiction.
- D. Water Service: Use of Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
 - 1. As soon as water is required at each level, extend service to form a temporary water- and fire-protection standpipe. Provide distribution piping. Space outlets so water can be reached with a 100-foot (30-m) hose. Provide one hose at each outlet.
 - 2. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
 - 2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
 - 3. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material

- handled.
 - a. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
 - 4. Drinking-Water Facilities: Provide bottled-water, drinking-water units.
 - a. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F.
 - 5. Locate toilets and drinking-water fixtures so personnel need not walk more than two stories vertically or 200 feet horizontally to facilities.
- F. Heating and Cooling: Provide temporary heating and cooling required by
- G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- 1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- H. Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnecting means, automatic ground-fault interrupters, and main distribution switchgear.
- 1. Connect temporary service to Owner's existing power source, as directed by electric company officials.
- I. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment complete with ground fault protection.
- 1. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
 - 2. Provide warning signs at power outlets other than 110 to 120 V.
 - 3. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or other traffic areas.
 - 4. Provide metal conduit enclosures or boxes for wiring devices.
 - 5. Provide 4-gang outlets, spaced so 100-foot extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.
- J. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.
- 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - 2. Install exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility when the Work is being performed.
- K. Telephone Service: Provide temporary telephone service throughout construction period for common-use facilities used by all personnel engaged in construction activities. Install separate telephone line for each field office and first-aid station.
- 1. Provide additional telephone lines for the following:
 - a. In field office with more than two occupants, install a telephone for each additional occupant or pair of occupants.
 - b. Provide a dedicated telephone line for each facsimile machine

- c. Provide high-speed internet service for each computer with modem in each field office.
 - d. Provide a separate telephone line for Owner's use.
 2. At each telephone, post a list of important telephone numbers.
 - a. Police Department
 - b. Fire Department
 - c. Ambulance service
 - d. Contractor's home office
 - e. Architect's office
 - f. Engineers' offices
 - g. Owner's office
 - h. Principal subcontractors' field and home offices
 3. Provide a portable cellular telephone with voice-mail capability for superintendent's use in making and receiving telephone calls when away from field office.
- L. Electronic Communication (E-mail) Service: Provide temporary electronic communication service, including electronic mail, in common-use facilities.
 1. Provide broadband in primary field office.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 1. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
 2. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 3. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate to support loads and to withstand exposure to traffic during construction period. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 2. Prepare subgrade and install sub base and base for temporary roads and paved areas according to Division 31, Section "Excavation and Fill."
 3. Recondition base after temporary use, including removing contaminated material, re-grading, proof rolling, compacting, and testing.
- C. Traffic Controls: Provide temporary traffic controls at junction of temporary roads with public roads. Include warning signs for public traffic and "STOP" signs for entrance onto public roads. Comply with requirements of authorities having jurisdiction.
 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Dewatering Facilities and Drains: Comply with requirements in applicable Division 31 for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual Sections. Where feasible, use same facilities. Maintain Project site, excavations, and construction free of water.
 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining property nor endanger permanent Work or temporary facilities.

2. Before connection and operation of permanent drainage piping system, provide temporary drainage where roofing or similar waterproof deck construction is completed.
- E. Project Identification and Temporary Signs: Prepare Project identification and other signs in sizes indicated. Install signs where indicated to inform public and persons seeking entrance to Project. Do not permit installation of unauthorized signs.
1. Engage an experienced sign painter to apply graphics for Project identification signs. Comply with details indicated.
 2. Prepare temporary signs to provide directional information to construction personnel and visitors.
 3. Construct signs of exterior-type Grade B-B high-density concrete form overlay plywood in sizes and thicknesses indicated. Support on posts or framing of preservative-treated wood or steel.
 4. Paint sign panel and applied graphics with exterior-grade alkyd gloss enamel over exterior primer.
- F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste. Comply with Division 01, Section "Common Execution Requirements" for progress cleaning requirements.
1. If required by authorities having jurisdiction, provide separate containers, clearly labeled, for each type of waste material to be deposited.
 2. Develop a waste management plan for Work performed on Project. Indicate types of waste materials Project will produce and estimate quantities of each type. Provide detailed information for on-site waste storage and separation of recyclable materials. Provide information on destination of each type of waste material and means to be used to dispose of all waste materials.
- G. Janitorial Services: Provide janitorial services on a weekly basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms, and similar areas. General cleaning shall be done by Contractor daily.
- H. Lifts and Hoists: Provide facilities for hoisting materials and personnel. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- I. Temporary Elevator Use: See Division 14 elevator Section for temporary use of new elevators.
- J. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near Project site.
- B. Storm water Control: Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm

water from heavy rains. Comply with Division 01 Section, "Erosion and Sedimentation Control".

- C. Tree and Plant Protection: Comply with requirements specified in Division 01, Section "Temporary Tree and Plant Protection."
- D. Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest-control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Engage this pest-control service to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials. Maintain site free of food scraps which might attract pests.
- E. Site Enclosure Fence: Before construction operations begin, install heavy wire mesh or chain-link enclosure fence with lockable entrance gates. Locate where indicated, or enclose entire Project site or portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering site except by entrance gates. Comply with Owner's Special Conditions, Project Fencing section 2.5.
 - 1. Set fence posts in compacted mixture of gravel and earth.
 - 2. Provide gates in sizes and at locations necessary to accommodate delivery vehicles and other construction operations.
 - 3. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys.
- F. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- G. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.
 - 1. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch-thick exterior plywood.
- H. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 - 2. Vertical Openings: Close openings of 25 sq. ft. or less with plywood or similar materials.
 - 3. Horizontal Openings: Close openings in floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
 - 4. Install tarpaulins securely using fire-retardant-treated wood framing and other materials.
 - 5. Where temporary wood or plywood enclosure exceeds 100 sq. ft. in area, use fire-retardant-treated material for framing and main sheathing.

- J. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
1. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.
 - a. Field Offices: Class A stored-pressure water-type extinguishers.
 - b. Other Locations: Class ABC dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.
 - c. Locate fire extinguishers where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
 2. Store combustible materials in containers in fire-safe locations.
 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for firefighting. Prohibit smoking in hazardous fire-exposure areas.
 4. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
 5. Permanent Fire Protection: At earliest feasible date in each area of Project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
 6. Develop and supervise an overall fire-prevention and first-aid fire-protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.5 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction. Remove and replace materials with mold.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard, replace or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in

- conditions.
 - 2. Use permanent HVAC system to control humidity.
 - 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
- E. Wet and Water-Damaged Materials:
- 1. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 24 hours are considered defective.
 - 2. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record daily readings over a forty-eight hour period. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - 3. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
 - 2. Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Temporary Facility Changeover: Except for using permanent fire protection as soon as available, do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are the property of Contractor. Owner reserves right to take possession of Project identification signs.
 - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 - 3. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements in Division 01, Section "Closeout Procedures."

END OF SECTION

01 60 00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Sections include:
 - 1. Division 01 Section "Allowances" for products selected under an allowance.
 - 2. Division 01 Section "Alternates" for products selected under an alternate.
 - 3. Division 01 Section "Substitution Procedures" for requests for substitutions.
 - 4. Division 01 Section "References" for applicable industry standards for products specified.

1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.3 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles. Note that no substitutions for convenience are allowed according to Division 01 Section "Substitutions."
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product

request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
- b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 6. Protect stored products from damage and liquids from freezing.
 7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a

- particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers and/or products, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and

other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Division 01 Section "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. Note that substitutions for convenience are not allowed according to Division 01 Section "Substitutions." If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
 - 1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - 3. Evidence that proposed product provides specified warranty.
 - 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 - 5. Samples, if requested.

PART 3 EXECUTION - Not applicable to this Section

END OF SECTION

01 72 00

COMMON EXECUTION REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. General installation of products.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.

- B. Related Sections include the following:
 - 1. Division 01 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
 - 2. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

- B. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

- C. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

- D. Certified Surveys: Submit two copies signed by land surveyor.

- E. Final Property Survey: Submit two copies showing the Work performed and record survey data.

1.3 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 PRODUCTS – Not Applicable to this Section

PART 3 EXECUTION

3.1 EXAMINATION

- A. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Written Report: Provide a written report listing conditions detrimental to performance of any and all Work, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2A, "Request for Information" form included at the end of in Division 01 Section "Substitutions."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.
 - 4. Check the location, level and plumb, of every major element as the Work progresses.
 - 5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and site work.
- E. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
 - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 - 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.

2. Where space is limited, comply with provisions of Section 01 31 06. Install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. Mounting Heights: Where mounting heights are not indicated, request clarification and mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction forces.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces, AV, IT, etc.
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction forces at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Assure there are no significant food matters in dumpster.
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
 - 1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
- H. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- K. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Manufacturer's representative shall be present for initial start up.
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust operating components for proper operation without binding. Adjust equipment for

proper operation.

- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.

1.2 DEFINITIONS

- A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.
- C. Cutting and patching is performed for coordination of the Work, to uncover Work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.
- D. Restoring or removing and replacing non-complying work is specified separately from cutting-and-patching, but may require cutting-and-patching operations as specified herein.

1.3 INFORMATIONAL SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
 - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - 2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - 3. Products: List products to be used and firms or entities that will perform the Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
 - 6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
 - 7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.4 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in

increased maintenance or decreased operational life or safety.

1. Primary operational systems and equipment.
 2. Air or smoke barriers.
 3. Fire-protection systems.
 4. Control systems.
 5. Communication systems.
 6. Conveying systems.
 7. Electrical wiring systems.
 8. Operating systems of special construction in Division 13 Sections.
- C. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
1. Water, moisture, or vapor barriers.
 2. Membranes and flashings.
 3. Exterior curtain wall construction.
 4. Equipment supports.
 5. Piping, ductwork, vessels, and equipment.
 6. Noise- and vibration-control elements and systems.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
1. If possible, retain original Installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage original Installer or fabricator, engage another recognized, experienced, and specialized firm.
 - a. Processed concrete finishes.
 - b. Stonework and stone masonry.
 - c. Ornamental metal.
 - d. Matched-veneer woodwork.
 - e. Preformed metal panels.
 - f. Roofing.
 - g. Firestopping.
 - h. Window wall system.
 - i. Stucco and ornamental plaster.
 - j. Terrazzo.
 - k. Finished wood flooring.
 - l. Fluid-applied flooring.
 - m. Aggregate wall coating.
 - n. Wall covering.
 - o. HVAC enclosures, cabinets, or covers.
- E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections of these Specifications.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
- B. Execute cutting, fitting and patching, including excavation and fill, to complete work and to:
 - 1. Fit the several parts together to integrate with other work.
 - 2. Uncover work to install ill-timed work.
 - 3. Remove and replace defective and nonconforming work.
 - 4. Remove samples of installed work for testing.
 - 5. Provide openings in elements of work for penetrations of mechanical and electrical work.
 - 6. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- C. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply

- with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- D. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- E. Fire Rated Construction: At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 13, to full thickness of the penetrated element.
- F. Roofing: Where penetrations are made through the roof system to accommodate mechanical, electrical, or plumbing systems, or any other reason associated with the Work, repair in accordance with the original manufacturer's requirements. Install curbs, cants, flashing and other roof system components in accordance with Specifications within this Project Manual and recommendations by the manufacturer of the roof system presently in place. Return assembly to weather-tight condition. Also refer to Division 07 section on roof modifications or repairs.
- G. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely

remove paint, mortar, oils, putty, and similar materials.

END OF SECTION

01 77 00

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
 2. Texas Accessibility Standards (TAS) inspection
 3. Warranties
 4. Instruction of Owner's personnel
 5. Final cleaning
 6. Owner's standard of care

1.2 SUBSTANTIAL COMPLETION

- A. "Substantial Completion" is the stage in the progress of Work when Work or designated portion thereof is sufficiently complete in accordance with Contract Documents so Owner can occupy or utilize Work for use which it is intended.
1. Work will not be considered suitable for Substantial Completion review until all systems and equipment are operational; all designated or required governmental inspections and certifications have been made and posted, designated instruction of Owner's personnel in operation of systems and equipment has been completed, operation and maintenance data has been satisfactorily turned over to the Owner, and all finishes are in place. In general, the only remaining Work shall be minor in nature, such that the Owner could occupy project or designated portion thereof on following day, and completion of Work by Contractor would not materially interfere or hamper Owner's normal business operations.
- B. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Advise Owner of pending insurance changeover requirements.
 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs and photographic negatives, damage or settlement surveys, property surveys, and similar final record information.
 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 8. Complete startup testing of systems.
 9. Terminate and remove temporary facilities from Project site, along with mockups,

- construction tools, and similar elements.
 - 10. Advise Owner of changeover in heat and other utilities.
 - 11. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 - 12. Complete final cleaning requirements, including touchup painting.
- C. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
- 1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
 - 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
- 1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
 - 2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 - 3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 - 4. Submit pest-control final inspection report and warranty.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
 - 6. Submit test/adjust/balance records.
 - 7. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
- 1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use attached CSI Form, or substantially similar form, and forward to Architect at time of request for Substantial Completion inspection. Architect may use same form for Architect's supplemental items to Contractor.
- 1. Organize list of spaces in sequential order.
 - 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 - 3. Include the following information at the top of each page:

- a. Project name
- b. Date
- c. Name of Architect
- d. Name of Contractor
- e. Page number

1.5 TEXAS ACCESSIBILITY STANDARD INSPECTION

- A. Provide inspection prior to Final Completion of facility in accordance with rules and regulation of the Texas Department of Licensing and Regulations (TDLR) for the purpose of determining compliance with the Texas Accessibility Standards. Inspector must be licensed with the Texas Department of Licensing and Regulations to perform the required inspection.
- B. Upon receipt of Inspector's report, immediately make corrections of any reported non-compliant items. Provide documentation to Owner of completed corrective measures.

1.6 PROJECT RECORD DOCUMENTS

- A. Refer to Section 01 78 39.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Section 01 78 23.

1.8 WARRANTIES

- A. Refer to Section 01 78 36.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 EXECUTION

3.1 DEMONSTRATION AND TRAINING

- A. Refer to Section 01 79 00.

3.2 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and anti-pollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program that is acceptable to the Owner and consistent with the Owner's standards of care. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

- b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - g. Sweep concrete floors broom clean in unoccupied spaces.
 - h. Power-wash concrete paving and parking areas, and concrete decks of parking garages.
 - i. Vacuum carpet and similar soft surfaces, including millwork, removing debris and excess nap; shampoo if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - s. Leave Project clean and ready for occupancy as acceptable to the Owner and their standards.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

3.3 FORMS (REFERENCE):

- A. Section 01 77 00x.....Completion/Correction Form, CSI Form 14.1A.
- B. Section 01 77 00xx.....Project Close-Out Checklist

C. Section 01 77 00xxx.....Facilities Infrastructure Asset Inventory Form.

END OF SECTION

01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Maintenance manuals for the care and maintenance of products, materials, and finishes, systems and equipment.
- B. Related Sections include the following:
 - 1. Division 01, Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
 - 2. Divisions 02 through 49 for specific operation and maintenance manual requirements for the Work in those Sections.

1.2 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 SUBMITTALS

- A. Ensure compliance with Uniform General and Supplemental Conditions.
- B. Initial Submittal: Submit 2 draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Architect will return 1 copy of draft and mark whether general scope and content of manual are acceptable.
- C. Final Submittal: Submit 1 copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.
 - 1. Correct or modify each manual to comply with Architect's comments. Submit one hard copy for Facilities and one electronic copy for FP&C (.pdf) of each corrected manual within 15 days of receipt of Architect's comments.

1.4 COORDINATION

- A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Organization. Include a section in the directory for each of the following:
 - 1. List of documents
 - 2. List of systems
 - 3. List of equipment
 - 4. Table of contents
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with the same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems".

2.2 MANUALS, GENERAL

- A. Organization. Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page
 - 2. Table of contents
 - 3. Manual contents
- B. Title Page. Enclose title page in transparent plastic sleeve. Include the following information:
 - 1. Subject matter included in manual
 - 2. Name and address of Project
 - 3. Name and address of Owner
 - 4. Date of submittal
 - 5. Name, address, and telephone number of Contractor
 - 6. Name and address of Architect
 - 7. Cross-reference to related systems in other operation and maintenance manuals
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
 - 1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary

to accommodate contents, sized to hold 8-1/2 X 11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

- a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders, if necessary, to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
 4. Supplementary Text: Prepared on 8-1/2 X 11-inch, 20-lb/sf white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
 1. Type of emergency
 2. Emergency instructions
 3. Emergency procedures
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 1. Fire
 2. Flood
 3. Gas leak
 4. Water leak
 5. Power failure
 6. Water outage
 7. System, subsystem, or equipment failure
 8. Chemical release or spill.
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

- D. Emergency Procedures. Include the following, as applicable:
 - 1. Instructions on stopping
 - 2. Shutdown instructions for each type of emergency
 - 3. Operating instructions for conditions outside normal operating limits
 - 4. Required sequences for electric or electronic systems
 - 5. Special operating instructions and procedures

2.4 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions
 - 2. Performance and design criteria if Contractor is delegated design responsibility
 - 3. Operating standards
 - 4. Operating procedures
 - 5. Operating logs
 - 6. Wiring diagrams
 - 7. Control diagrams
 - 8. Piped system diagrams
 - 9. Precautions against improper use
 - 10. License requirements including inspection and renewal dates
- B. Descriptions. Include the following:
 - 1. Product name and model number
 - 2. Manufacturer's name
 - 3. Equipment identification with serial number of each component
 - 4. Equipment function
 - 5. Operating characteristics
 - 6. Limiting conditions
 - 7. Performance curves
 - 8. Engineering data and tests
 - 9. Complete nomenclature and number of replacement parts
- C. Operating Procedures. Include the following, as applicable:
 - 1. Startup procedures
 - 2. Equipment or system break-in procedures
 - 3. Routine and normal operating instructions
 - 4. Regulation and control procedures
 - 5. Instructions on stopping
 - 6. Normal shutdown instructions
 - 7. Seasonal and weekend operating instructions
 - 8. Required sequences for electric or electronic systems
 - 9. Special operating instructions and procedures
- D. Systems and Equipment Controls: Describe the sequence of operation and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.5 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material,

and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

- B. Source Information: List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information. Include the following, as applicable:
 - 1. Product name and model number
 - 2. Manufacturer's name
 - 3. Color, pattern, and texture
 - 4. Material and chemical composition
 - 5. Reordering information for specially manufactured products
- D. Maintenance Procedures. Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures
 - 2. Types of cleaning agents to be used and methods of cleaning
 - 3. List of cleaning agents and methods of cleaning detrimental to product
 - 4. Schedule for routine cleaning and maintenance
 - 5. Repair instructions
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
 - 2. Contact data for all equipment and warranty issues - post in view on all equipment.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in the manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation. Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard printed maintenance instructions and bulletins
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly
 - 3. Identification and nomenclature of parts and components

4. List of items recommended to be stocked as spare parts
- D. Maintenance Procedures. Include the following information and items that detail essential maintenance procedures:
 1. Test and inspection instructions
 2. Troubleshooting guide
 3. Precautions against improper maintenance
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions
 5. Aligning, adjusting, and checking instructions
 6. Demonstration and training videotape, if available
- E. Maintenance and Service Schedules. Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent - post in view of/on all equipment.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
- I. Include procedures to follow and required notifications for warranty claims.

PART 3 EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble complete set of emergency information indicating procedures for use by emergency personnel and Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

- E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
1. Do not use original Project Record Documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared Record Drawings in Division 01, Section "Project Record Documents."
- G. with Division 01, Section "Closeout Procedures" for the schedule for submitting operation and maintenance documentation.

END OF SECTION

02 00 00

EXISTING CONDITIONS

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. 00 31 32 Geotechnical Report
- B. 01 40 00 Quality Requirements
- C. 01 70 00 Execution and Closeout Requirements

1.2 SUMMARY

- A. Use of Survey provided in Project Documents.
- B. Construction Work on site.
- C. Unforeseen Conditions.

PART 2 PRODUCTS - Not applicable to this Section

PART 3 EXECUTION

3.1 EXISTING CONDITIONS REPRESENTED ON SITE SURVEY

- A. Existing site setbacks and easements shall be respected throughout construction, unless express written permission is given by the Owner to do otherwise.
 - 1. Omission of setbacks and easements from the Architectural and/or Civil Site Drawings does not absolve the Contractor from Following Setbacks indicated in the Survey.
- B. Refer to Survey Jones|Carter Job No. R0001-0202-00 DWG No. 13690, generated for this project.
- C. Existing utilities, sewers, or other services on site that serve other structures or properties shall be protected during construction.
 - 1. Architect must be notified at once if utilities, sewers, or other services not appearing on the Survey are discovered on site.
 - 2. Architect must be notified at once if utilities, sewers, or other services conflict with proposed work.

3.2 EXISTING STRUCTURES AND FACILITIES ON SITE.

- A. Construction Operations: Do not damage building elements and improvements indicated to remain.
- B. Utilities: Locate, identify, disconnect, and seal or cap off utilities in buildings to be demolished.
- C. Occupied Structures and Adjacent Facilities: Do not close or obstruct streets, walks, drives or other occupied or used spaces or facilities without the written permission of the Owner

and the authorities having jurisdiction. Do not interrupt utilities serving occupied or used facilities without the written permission of the Owner and authorities having jurisdiction. If necessary, provide temporary utilities.

- D. Operations: Cease operations if public safety or remaining structures are endangered. Perform temporary corrective measures until operations can be continued properly.
- E. Security: Provide adequate protection against accidental trespassing. Secure project after work hours.
- F. Restoration: Restore sidewalks, driveways, landscape, and other site elements indicated to remain, if damaged by construction.

3.3 UNFORESEEN CONDITIONS

- A. Notify Architect at once of any unforeseen conditions on site that may affect the work.

END OF SECTION

SECTION 03 05 80
UNDER-SLAB VAPOR BARRIER/RETARDER

PART 1 - GENERAL

1.1 SUMMARY

- A. Products Supplied Under This Section
 - 1. Vapor Barrier, seam tape, mastic, pipe boots, detail strip for installation under concrete slabs.
- B. RELATED SECTIONS
 - 1. Section 03 30 00 Cast-in-place Structural Concrete
 - 2. Section 01 45 23 Structural Testing and Inspection

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM E 1745-97 (2004) Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
 - 2. ASTM E 154-88 (2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
 - 3. ASTM E 96-95 Standard Test Methods for Water Vapor Transmission of Materials
 - 4. ASTM E 1643-98 (2005) Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
- B. American Concrete Institute (ACI)
 - 1. ACI 302.2R-06 Vapor Barrier Component (plastic membrane) is not less than 10 mils thick.

1.3 SUBMITTALS

- A. Quality Control / Assurance
 - 1. Full set of test results as per paragraph 8.3 of ASTM E 1745.
 - 2. Manufacturer's samples, literature
 - 3. Manufacturer's installation instructions for placement, seaming and pipe boot installation.

1.4 SUBSTITUTIONS

- A. Product Review
 - 1. Request must be made 14 days prior to bid date to allow time for proper review. Reviews will be at contractor's expense.
 - 2. Independent laboratory test results showing compliance with ASTM E 1745 Class A, a permeance less than 0.01 Perms (grains/(ft² *hr * in. Hg) before and after the

- mandatory conditioning tests ASTM E 154 Sections 8,11,12, and 13. (Woven, and recycled plastics are not permitted)
3. Incomplete substitutions will not be accepted.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Vapor Barrier (Performance based specification). When the specifications of different sections conflict, the contractor shall perform to the most restrictive provision. Vapor Barrier membrane must have the following properties.
 1. Permeance as tested after mandatory conditioning (ASTM E 154 sections 8,11,12,13) less than 0.01 Perms [grains/(ft² *hr * in.Hg)]
 2. Other performance criteria
 - a. Strength: ASTM E 1745 Class A
 - b. Thickness: 15 mils minimum

2.2 ACCESSORIES

- A. Seam Tape
 1. Tape must have the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96, 0.3 perms or lower
 2. Seam Tape
 - a. Manufacturer's standard seam tape.
 - b. Stego Crete Claw (for slabs on void boxes).
- B. Vapor Proofing Mastic
 1. Mastic must have the following qualities:
 - a. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower
- C. Pipe Boots
 1. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer's instructions.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ensure that subsoil is approved by architect or geotechnical firm
 1. Level and tamp or roll aggregate, sand or tamped earth base.

3.2 INSTALLATION

- A. Install Vapor Barrier/Retarder:
 1. Installation shall be in accordance with manufacturer's written instructions and ASTM E 1643-09.

- a. Unroll Vapor Barrier/Retarder with the longest dimension parallel with the direction of the pour.
- b. Lap Vapor Barrier/Retarder over footings or seal to foundation walls.
- c. Overlap joints 6 inches and seal with manufacturer's tape.
- d. Seal all penetrations (including pipes) per manufacturer's instructions.
- e. No penetration of the Vapor Barrier/Retarder is allowed except for reinforcing steel and permanent utilities.
- f. Repair damaged areas by cutting patches of Vapor Barrier/Retarder, overlapping damaged area 6 inches and taping all four sides with tape.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cast-in-place concrete formwork, for the following:
1. Footings and/or piers.
 2. Foundation walls.
 3. Slabs-on-grade.
 4. Suspended slabs.
 5. Concrete toppings.
 6. Building frame members.
 7. Building walls.
- B. Related Sections:
1. Section 01 45 23 "Testing and Inspection Services".
 2. Section 03 30 00 "Cast In Place Concrete".
 3. Section 03 20 00 "Concrete Reinforcing".
 4. Section 03 38 16 "Unbonded Post Tensioned Concrete".

1.3 REFERENCES

- A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
1. American Concrete Institute (ACI):
 - a. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
 - b. ACI 301 – Specifications for Structural Concrete for Buildings
 - c. ACI 318 – Building Code Requirements for Structural Concrete
 - d. ACI 347 – Guide to Formwork for Concrete
 - e. ACI SP-4 – Formwork for Concrete.

1.4 PERFORMANCE REQUIREMENTS

- A. Design and engineering of formwork, including shores, reshores, false work, bracing, and other temporary supports as well as determining when temporary supports and bracing can safely be removed after the specified curing time is the Contractor's responsibility.

- B. All components of the formwork shall be designed to support all loads imposed during construction including weight of construction equipment, live loads, and lateral loads due to wind and imbalance or discontinuity of building components.
- C. If any post tensioned members exist on the project, the formwork supporting those elements shall:
 - 1. It is essential to take into account the stressing sequence of post-tensioned concrete in the design of the formwork. Any concrete element which is stressed can transfer its weight off the form work to the supporting concrete element in which case the forms for the supporting concrete element must be designed to support the entire load tributary of that element.
 - 2. Forms shall be designed and constructed to permit movement during stressing, both lifting and shortening of the concrete elements.
 - 3. Formwork supporting beams and girders shall be designed to support the weight of the beam or girder's entire tributary area.
 - 4. Formwork supporting post tensioned concrete elements shall not be removed until all concrete supported by the formwork has been fully stressed, but in no case shall the curing time before form removal be less than specified herein.
 - 5. Design, engineering and production of shop drawings for the form work shall be performed under the supervision of a professional engineer.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
- C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Shop drawings for layout of pan type forms, if they exist on the project. Layout only - information and details about the support of these forms is not required, as it is the responsibility of the Contractor and his registered engineer
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- D. Manufacturer's product data and installation instruction for propriety materials used in exposed concrete work including form liners, release agents, form systems, ties, and accessories.
- E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver form materials in manufacturer's packaging with installation instructions.
- B. Store off ground in ventilated and protected area to prevent deterioration from moisture or damage.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician. An experienced installer who has completed work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in service performance.
- B. Testing Agency Qualifications: Refer Section 01 45 23.
- C. Layout and measurement of concrete forms and embedment's, required for work, performed by a licensed surveyor employed by the contractor.
- D. Design, engineering and construction, and removal of formwork are the responsibility of the contractor.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specifications for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

- D. Permanent Metal Forms for Slabs: Deck material, gauge and rib pattern shall be as noted on Drawings.
- E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
 - 1. Pans shall be free of dents, irregularities, sag, rust or other deterioration.
 - 2. In areas permanently exposed to view, provide one piece units, manufactured to length between beams or ribs, or segmented units with reinforced butt-joint splices.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch
 - 3. Class C, 1/2 inch
 - 4. Class D, 1 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Coordinate work of other Sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts that are attached to the formwork.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 3. Install dovetail anchor slots in concrete structures as indicated.
 4. Install accessories in accordance with manufacturer's instructions, level and plumb. Ensure items are not disturbed during concrete placement.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
 3. Determine compressive strength of in place concrete by testing representative field-cured test specimens according to ACI 301.
- B. Obtaining concrete compressive strength tests for the purposes of form removal shall be the responsibility of the Contractor.
- C. In the absence of cylinder tests, formwork shall remain in place until the concrete has cured at a temperature of at least 50 degrees Fahrenheit (10 degrees Celsius) for the minimum cumulative time periods given in ACI 347, Section 3.7.2.3. When the surrounding air temperature is below 50 degrees Fahrenheit (10 degrees Celsius), that time period shall be added to the minimum listed time period.
- D. Formwork for two-way conventionally reinforced slabs shall remain in place for at least the minimum cumulative time periods specified for one-way slabs of the same maximum span. Two-way conventionally reinforced slabs shall then be reshored until they attain the specified 28 day strength.
- E. Minimum cumulative curing times may be reduced by the use of high-early strength cement or forming systems that allow form removal without displacing shores. However, the Contractor must demonstrate, to the satisfaction of the Architect, that the early removal of forms will not result in excessive sag, distortion or damage to the concrete elements.
- F. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- G. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. The Contractor shall be solely responsible for proper shoring and reshoring. Locate and provide adequate reshoring to support construction without excessive stress or deflection.
- C. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement. Reshores shall be located in the same position on each floor. No construction loads shall be placed on the new construction until all supporting reshores have been installed.
1. Extend shores or reshores from ground to top level in structure three stories or less in height, unless noted otherwise.

2. In structures over three stories in height, extend shores or reshores at least three levels under the level being placed. Extend shores beyond the minimum number of levels if required to ensure proper distribution of loads throughout the structure.
 3. In crawl spaces or basement, shores or reshores shall extend to mud pads seated firmly on the soil or to on grade construction.
- D. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.
- E. Bottom tier of reshores shall remain in place until the supported concrete has attained at least 85 percent of the specified 28 day compressive strength and construction loads in excess of 20 psf have been removed but not less than 14 days.

3.5 REUSE OF FORMS

- A. Clean and repair surfaces of forms to be used in the Work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form release agent.
- B. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Otherwise, locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are to be installed.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - 1. Apply scratch finish to surfaces indicated or to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.

- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated or to receive trowel finish or to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cast-in-place concrete reinforcement, for the following:
1. Footings and/or piers.
 2. Foundation walls.
 3. Slabs-on-grade.
 4. Suspended slabs.
 5. Concrete toppings.
 6. Building frame members.
 7. Building walls.
- B. Related Sections:
1. Section 01 45 23 "Testing and Inspection Services".
 2. Section 03 10 00 "Concrete Forming and Accessories".
 3. Section 03 30 00 "Cast In Place Concrete".
 4. Section 03 38 16 "Unbonded Post Tensioned Concrete".
 5. Section 04 22 00 "Concrete Unit Masonry".
 6. Section 31 20 00 "Earth Moving".
 7. Section 31 63 29 "Drilled Concrete Piers and Shafts".

1.3 REFERENCES

- A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
1. American Concrete Institute (ACI)
 - a. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
 - b. ACI 301 – Specifications for Structural Concrete for Buildings
 - c. ACI 315 – Details and Detailing of Concrete Reinforcement
 - d. SP-66 ACI Detailing Manual
 2. American Welding Society (AWS)
 - a. AWS D1.1 – Structural Welding Code
 3. Concrete Reinforcing Steel Institute (CRSI)
 - a. CRSI – Manual of Standard Practice
 - b. CRSI 63 – Recommended Practice for Placing Reinforcing Bars
 - c. CRSI 65 – Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.

- B. American Society of Testing Materials (ASTM)
 - a. ASTM-A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement.
 - b. ASTM-A663: Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
 - c. ASTM-A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. ASTM-A675: Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
 - e. ASTM-A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - f. ASTM-A775: Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 - g. ASTM-A884: Standard Specification for Epoxy-Coated Wire and Welded Wire Reinforcement.

- C. In the case of conflict between the Contract Documents and a reference standard, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the Building Code, the more stringent shall govern.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement, according to ACI 315 "Details and Detailing of Concrete Reinforcement."
 - 1. Do not reproduce the structural drawings for use as shop drawings.

- D. Bar Supports: Submit manufacturer's product information for bolsters, chairs, spaces, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency, installer, and fabricator as indicated herein.

- B. Welding certificates.

- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Steel reinforcement and accessories.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Refer Section 01 45 23.
- B. Installer Qualifications: An experienced installer who has completed reinforcing installation work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in service performance.
- C. Fabricator Qualifications: An experienced fabricator who has completed reinforcing fabrication work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in service performance.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code - Reinforcing Steel."
- E. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings, if any, on steel reinforcement.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615, Grade 60 for #6 and smaller bars, Grade 75 for #7 and larger bars, deformed.
- C. Low-Alloy-Steel Reinforcing Bars for bars to be welded: ASTM A 706, Grade 60 for #6 and smaller bars, Grade 75 for #7 and larger bars, deformed.
- D. Stainless-Steel Reinforcing Bars: ASTM A 955, Grade 60, [Type 304] [Type 316L], deformed.

- E. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615, Grade 60 or ASTM A 706, deformed bars, assembled with clips.
- F. Plain-Steel Wire: ASTM A 82, as drawn .
- G. Deformed-Steel Wire: ASTM A 496.
- H. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.
- I. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, or other unacceptable materials.

2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice." Combined tolerances for formwork, reinforcing fabrication, and reinforcing placement shall not permit a reduction in specified concrete cover of reinforcing steel. In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken material. Bars used for concrete reinforcement shall meet following requirements for fabricating tolerances:
 - 1. Sheared length: Plus or minus 1 inch.
 - 2. Depth of truss bars: Plus 0, minus ½ inch.
 - 3. Overall dimensions of stirrups, ties, and spirals: Plus or minus ½ inch.
 - 4. Other bends: Plus or minus 1 inch.
- B. For bars with end bearing splice couplers, bar ends shall terminate in flat surfaces, within 1.5 degrees of a right angle to axis of bars and shall be fitted within 3 degrees of full bearing after assembly.

2.4 DOWEL BAR ANCHORS/SPLICERS

- A. A. Provide dowel bar anchors and threaded dowels designed to develop, both in tension and compression, 125% of the minimum ASTM specified yield strength of the dowel bars, as evidenced by published I.C.B.O. test reports. Unless otherwise indicated, anchors

shall be furnished with ACI standard 90 degree hooks. Dowels shall be furnished by anchor supplier. The following dowel splicing systems are acceptable.

1. Richmond Screw Anchor "Dowel Bar Splicer"
2. Erico "Lenton Form Saver"
3. Dayton Barsplice "Grip-Twist"

2.5 MECHANICAL SPLICES

- A. Provide mechanical splices designed to develop, both in tension and compression, 125% of minimum ASTM yield strength of the smaller bar being coupled, as evidenced by published I.C.B.O test reports. The following bar splicing systems are acceptable.
1. Erico "Cadweld C-Series"
 2. Erico "Lenton"
 3. Dayton Barsplice "Bar Grip"
 4. Dayton Barsplice "Grip Twist"

2.6 METAL ANCHORAGE AND EMBEDDED METAL ASSEMBLIES

- A. Steel Shapes and Plates: Conform to ASTM A36, "Specification for Structural Steel".
- B. Headed Stud Anchors: Headed studs welded by full fusion process, as furnished by TRW Nelson Stud Welding Division.
- C. Welding Electrodes: AWS 5.5, Series E70.
- D. Welded Deformed Bar Anchors: Welded by full fusion process, as furnished by TRW Nelson Stud Welding Division.
- E. All metal assemblies exposed to earth, weather or moisture, including exposure to a crawl space environment, shall be hot dip galvanized.

2.7 FABRICATION OF METAL ACCESSORIES AND EMBEDDED METAL ASSEMBLIES

- A. Fabricate and assemble structural steel items in the shop. Shearing, flame cutting, and chipping shall be done carefully and accurately. Holes shall be cut, drilled, or punched at right angles to the surface of metal and shall not be made or enlarged by burning. Holes shall be clean-cut without torn or ragged edges. Welded construction shall conform to AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings," and AWS D1.1. Welding shall be done by AWS certified welders.
- B. Welding of deformed bar anchors and headed stud anchors shall be done by full fusion process equal to that of TRW Nelson Stud Welding Division of KSM Welding Services Division, Omark, Ind. A minimum of two headed studs shall be tested at start of each production period for proper quality control. Studs shall be capable of being bent 45 degrees without weld failure.
- C. Welding of reinforcement shall be done in strict accordance with AWS requirements, using recommended preheat temperature and electrode for type of reinforcement being welded. Bars larger than No. 9 shall not be welded. Welding shall be performed subject

to the observance and testing laboratory. Under no circumstances is ordinary reinforcing (ASTM A615) to be welded.

- D. Coatings, where required, shall be applied after fabrication and prior to casting concrete.

PART 3 - EXECUTION

3.1 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 3. Install dovetail anchor slots in concrete structures as indicated.

3.2 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
1. Weld reinforcing bars according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Provide minimum concrete covering for reinforcement as shown in the Structural General Notes.
- G. Place bars to following tolerances:
1. Clear distance to formed surfaces: Plus or minus ¼ inch.
 2. Minimum spacing between bars: Minus ¼ inch.
 3. Top bars in slabs and beams:
 - a. Members 8 inches deep or less: Plus or minus ¼ inch.

- b. Members between 8 and 24 inches deep: Plus or minus ½ inch.
 - c. Members more than 24 inches deep: Plus or minus 1 inch.
- 4. Crosswise of members: Spaced evenly within 2 inches.
- 5. Length of members: Plus or minus 2 inches.

- H. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If moved more than one bar diameter, or enough to exceed above tolerances, resulting arrangement of bars subject to approval.

- I. Support reinforcement and fasten together to prevent displacement by construction loads or placing concrete beyond tolerances indicated.

- J. Unless permitted by Engineer, do not bend reinforcement after embedding in hardened concrete.

3.3 FIELD QUALITY CONTROL

- A. Testing and Inspecting: See Section 01 45 23.

- B. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.

END OF SECTION

SECTION 03 21 00 – CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This WORK shall consist of furnishing and placing reinforcing steel in accordance with these SPECIFICATIONS and in conformity with the DRAWINGS.

1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
 - 1. Section 03 31 00, Structural Concrete.

1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Association of State and Highway Transportation Officials (AASHTO):
 - a. M31M/M31, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - b. AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.
 - 2. American Concrete Institute (ACI):
 - a. ACI Detailing Manual.
 - b. 117, Specifications for Tolerance for Concrete Construction and Materials.
 - c. 318, Building Code Requirements for Structural Concrete.
 - 3. American Welding Society (AWS):
 - a. D1.1/D1.1M, Structural Welding Code - Steel.
 - b. D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
 - c. D2.0, Welded Highway and Railway Bridges.
 - 4. ASTM International (ASTM):
 - a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

- c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A996/A996M, Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
 - e. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - f. A767/A767M, Standard Specification for Zinc-coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - g. A775/A775M, Standard Specification for Epoxy-coated Steel Reinforcing.
5. Concrete Reinforcing Steel Institute (CRSI):
- a. Manual of Standard Practice.
 - b. Placing Reinforcing Bars.

1.04 SUBMITTALS

- A. Two copies of a list of all reinforcing steel and bending diagrams shall be furnished to the ENGINEER at the site of the work at least one week before the placing of reinforcing steel is begun. Such lists will not be reviewed for accuracy. The CONTRACTOR shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the plans.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. Reinforcing steel shall be stored off of the ground and protected from oil or other materials detrimental to the steel or bonding capability of the reinforcing bar. Epoxy coated reinforcing bars shall be stored on protective cribbing.

PART 2 PRODUCTS

2.01 REINFORCING STEEL

- A. Deformed Bars: All bar steel reinforcement shall be of the deformed type, ASTM A615, AASHTO M31M/M31, and Grade (40 or 60) as specified on the DRAWINGS. B. Spirals:
 - 1. Spirals, hot-rolled plain or deformed bars per ASTM A615, Grade 60 or cold drawn wire per ASTM A82/A82M as specified on the DRAWINGS.
 - 2. Spirals for columns shall have two (2) "spacers" with a section modulus 0.030in³ in order to maintain the proper pitch and spacing.
- C. Epoxy-Coated Reinforcing Bars: Epoxy-coated reinforcing bars shall conform to ASTM A775/A775M. When required, damaged epoxy coating shall be repaired with patching material conforming to ASTM A775/A775M in accordance with the material manufacturer's recommendations.

- D. Zinc-coated (Galvanized Reinforcing Bars): Zinc-coated reinforcing bars shall conform to ASTM A767/A767M. When required, damaged zinc coating shall be repaired with a zinc-rich formulation conforming to ASTM A767/A767M.
- E. Welded Wire Fabric: All welded wire fabric reinforcement shall conform to ASTM A497/A497M. F. Identification:
 - 1. Bundles of reinforcing bars and wire spirals shall be tagged, with a metal tag, showing specification, grade, size, quantity, and suitable identification to permit checking, sorting, and placing. When bar marks are used to identify reinforcing bars on the DRAWINGS, the bar mark shall be shown on the tag. Tags shall be removed prior to concrete placement.
 - 2. Bundles of flat sheets and rolls of welded wire fabric shall be tagged similar to reinforcing bars.

2.02 TIE WIRE

- A. 16-gauge wire ties, manufactured by American Wire Tie, Inc., or equal. When epoxy-coated reinforcing steel is shown on the DRAWINGS, PVC coated wire ties shall be used. The minimum PVC coating shall be 0.7 mils.

2.03 BAR SUPPORTS

- A. General: Bar supports and spacing shall be in accordance with the CRSI Manual of Standard Practice, Chapter 3, a maximum of four (4) feet, or as required by the DRAWINGS.
- B. Floor Slabs: Uncoated steel or non-metallic composite chairs shall be used unless otherwise shown on the DRAWINGS. If required by ENGINEER, the chair shall be stapled on a bearing pad to prevent chair displacement. The bearing pad shall be made of exterior grade plywood and be approximately five (5) inches square.
- C. Columns: Plastic "space wheels" manufactured by Aztec (Model DO 12/40), or equal, are required.
- D. Epoxy-Coated and Zinc-Coated Bar Supports: Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports made of dielectric or other acceptable materials. Wire supports shall be fully coated with dielectric material, compatible with concrete. Reinforcing bars used as support bars shall be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing shall be made of corrosion-resistant material or coated with dielectric material.

2.04 FABRICATION

- A. Fabrication tolerances for straight and bent bars shall be in accordance with the requirements of Subsection 4.3, Tolerance, of ACI 315 and the CRSI Manual of Standard Practice.

PART 3 EXECUTION

3.01 GENERAL

- A. Rust, seams, surface irregularities, or mill scale shall not be cause for rejection provided that the weight and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM Specification.

3.02 BAR LIST

- A. CONTRACTOR shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the DRAWINGS.
- B. Bar lists and bending diagrams for structures, which are included on the DRAWINGS, do not have to be furnished by CONTRACTOR. When bar lists and bending diagrams are included on the DRAWINGS, they are intended for estimating approximate quantities. CONTRACTOR shall verify the quantity, size, and shape of the bar reinforcement against those shown on the DRAWINGS and make any necessary corrections before ordering.

3.03 BENDING

- A. All reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent, except as shown on the DRAWINGS or permitted. Bars shall not be bent or straightened in a manner that may injure the material.

3.04 SPIRALS

- A. One and one-half (1-1/2) finishing bends are required at the top and bottom of the spiral. Spacers shall be provided in accordance with Chapter 5, Section 9 of the CRSI Manual of Standard Practice. Welding as an aid to fabrication and/or installation is not permitted.

3.05 PLACING AND FASTENING

- A. When placed in the WORK, the reinforcing bars shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.
- B. The placing, fastening, splicing, and supporting of reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the DRAWINGS and the latest edition of "CRSI Placing Reinforcing Bars." In case of discrepancy between the DRAWINGS and the CRSI publication stated above, the DRAWINGS shall govern. Reinforcement shall be placed within the tolerances provided in ACI 117.
- C. Steel reinforcement shall be accurately placed in the positions shown on the DRAWINGS and firmly held during the placing and setting of concrete by means of spacer strips, stays, metal chairs or other approved devices or supports. Precast concrete bricks or other types of bricks are not permitted for support of reinforcement in footings, slabs, or any other part of the work. Chair and bolster supports for slabs and walls shall be spaced at a maximum of four- (4-) foot centers unless otherwise shown on the DRAWINGS. Staples used to attach bar supports to wall and roof forms shall have the staple "tails" clipped after form removal. For columns, three (3) wheels, spaced one hundred twenty degrees (120°) apart, shall be placed every four (4) feet of column height.

CONTRACTOR may increase the column spiral pitch if a conflict occurs with the wheel. Pre-tied column reinforcing steel lowered into column forms shall be lowered vertically to prevent damage to the space wheels.

- D. Bars shall be securely tied at fifty percent (50%) of all intersections except where spacing is less than one (1) foot in each direction, when alternate intersections shall be tied unless otherwise called out on the DRAWINGS or in applicable SPECIFICATIONS. Tying of steel by spot welding shall not be permitted unless specifically authorized by ENGINEER. The placing and securing of the reinforcement in any unit or section shall be accepted by ENGINEER before any concrete is placed in any such unit or section.
- E. Bundle bars shall be tied together at not more than six- (6-) foot centers.

3.06 SPLICING

- A. Bar steel reinforcement shall be furnished in the full lengths indicated on the DRAWINGS. Splicing of bars, except where shown on the DRAWINGS, shall not be permitted without the written acceptance of ENGINEER. Splices shall be staggered.
In cases where permission is granted to splice bars, other than those shown on the DRAWINGS, the additional material required for the lap shall be furnished by CONTRACTOR at CONTRACTOR's own expense. The minimum distance between staggered splices for reinforcing bars shall be the length required for a lapped splice in the bar. All splices shall be full contact splices.
- B. Splices shall not be permitted at points where the section is not sufficient to provide a minimum distance of two (2) inches between the splice and the nearest adjacent bar or the surface of the concrete.
- C. Welding of reinforcement shall be done only if detailed on the DRAWINGS or if authorized by ENGINEER in writing. Welding shall be done by a certified welder. The welding shall conform to AWS D1.4/D1.4M with the modifications and additions specified hereinafter. Where AWS D2.0 Specifications for Welded Highway and Railway Bridges is referenced, the reference shall be construed to be for AWS D1.1. Where the term AWS D1.1/D1.1M is used it shall mean the American Welding Society Structural Welding Code, D1.5/D1.5M as modified and amended by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. After completion of welding, coating damage to coated reinforcing steel bars shall be repaired.
- D. When required or permitted, a mechanical connection may be used to splice reinforcing steel bars or as substitution for dowel bars. The mechanical connection shall be capable of developing a minimum of one hundred twenty five percent (125%) of the yield strength of the reinforcing bar in both tension and compression.
All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

3.07 CUTTING

- A. When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

END OF SECTION 03 21 00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
1. Footings.
 2. Foundation walls.
 3. Slabs-on-grade.
 4. Suspended slabs.
 5. Concrete toppings.
 6. Building frame members.
 7. Building walls.
- B. Related Sections:
1. Section 01 45 23 "Structural Testing and Inspection Services".
 2. Section 03 20 00 "Concrete Forming and Accessories".
 3. Section 03 10 00 "Concrete Reinforcing".
 4. Section 03 15 13 "Waterstops".
 5. Section 03 05 80 "Under-slab Vapor Barrier – Retarder".
 6. Section 31 63 29 "Drilled Concrete Piers and Shafts".

1.3 REFERENCES

- A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
1. ACI 301 – Specification for Structural Concrete.
 2. ACI 302 – Guide for Concrete Floor Slab Construction.
 3. ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete.
 4. ACI 305 – Hot Weather Concreting.
 5. ACI 306 – Cold Weather Concreting.
 6. ACI 308 – Guide to Curing Concrete.
 7. ACI 309 – Guide for Consolidating Concrete.
 8. ACI 311 – ACI Manual for Concrete Inspection.
 9. ACI 318 – Building Code Requirements for Reinforced Concrete.
 10. ACI 347 – Guide to Concrete Formwork.
 11. ACI 207 – Mass Concrete.

12. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
13. ACI 211.2 – Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
14. ACI 212.3 – Chemical Admixture for Concrete.
15. ACI 212.4 – Guide for the use of High Range Water Reducing Admixtures in Concrete.
16. ACI 214 – Evaluation of Strength Test Results of Concrete.
17. ACI 303 – Guide to Cast in Place Architectural Concrete Practice.
18. Concrete Reinforcing Steel Institute, "Manual of Standard Practice".

- B. In the case of conflict between the Contract Documents and a referenced standard, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the Building Code, the more stringent shall govern.

1.4 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 2. Product Data for Credit IEQ 4.3: For liquid floor treatments and curing and sealing compounds, documentation including printed statement of VOC content.
 3. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for Portland cement or other Portland cement replacements, and for equivalent concrete mixtures that do not contain Portland cement replacements.
- C. Design Mixtures: For each concrete mixture include the following information. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
1. Each proposed mix design shall be accompanied by a complete standard deviation analysis based on at least 30 consecutive strength tests, or by three laboratory trial mixtures with confirmation tests.
 2. Proportions of cement, fine, and coarse aggregate, and water.
 3. Design strength.
 4. Maximum slump.
 5. Air Content.
 6. Maximum water / cement ratio.
 7. Maximum and minimum concrete temperature that is acceptable at time of placement for which the manufacturer can guarantee the strength of the concrete.

8. Type cement and aggregates.
 9. Type and quantities of all admixtures.
 10. Air dry density and splitting tensile strength for lightweight concrete determined in accordance with ASTM 330.
 11. Type, color, and quantities of integral coloring compounds, where applicable.
 12. Indicate amounts of mixing water to be withheld for later addition at Project site.
- D. Steel Reinforcement Shop Drawings: Refer Section 03 20 00.
- E. Formwork Shop Drawings: Refer Section 03 10 00.
- F. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
1. Location of construction joints is subject to approval of the Architect.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
 2. Admixtures.
 3. Fiber reinforcement.
 4. Curing compounds.
 5. Floor and slab treatments.
 6. Bonding agents.
 7. Adhesives.
 8. Semi rigid joint filler.
 9. Joint-filler strips.
 10. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- F. Field quality-control reports.
- G. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: See Section 01 45 23.
 - 1. Contractor's responsibility to testing laboratory.
 - a. Furnish all labor and materials as required to assist testing agency in obtaining, making and handling samples at the jobsite.
 - b. Advise the Owner's Testing Laboratory sufficiently in advance of operations to allow adequate time for the assignment of testing personnel.
 - c. Furnish and maintain adequate facilities for proper curing of concrete test specimens on the project site in accordance with ASTM C31.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code - Reinforcing Steel."
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specifications for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- G. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
 - 1. Build panel approximately 200 sq. ft. for slab-on-grade and 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.
- H. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings, if any, on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. See Section 03 10 00.

2.2 STEEL REINFORCEMENT

- A. See Section 03 20 00.

2.3 REINFORCEMENT ACCESSORIES

- A. See Section 03 20 00.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I or Type I/II, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F or C. Carbon content shall not exceed 3 percent by volume.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years of satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches, 1 inch, or 3/4 inch nominal as indicated on Drawings for specific uses.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Lightweight Aggregate: ASTM C 330, 3/4-inch nominal maximum aggregate size.
- D. Water: ASTM C 94 and potable.

2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that contain not more than 0.05 percent water soluble chloride ions. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494, Type A.
 - 2. Retarding Admixture: ASTM C 494, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
- C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ChemMasters.
 - b. Davis Colors.
 - c. Dayton Superior Corporation.
 - d. Hoover Color Corporation.
 - e. Lambert Corporation.
 - f. QC Construction Products.
 - g. Rockwood Pigments NA, Inc.
 - h. Scofield, L. M. Company.
 - i. Solomon Colors, Inc.
 - 2. Color: As selected by Architect from manufacturer's full range.

2.6 FIBER REINFORCEMENT

- A. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1 to 2-1/4 inches long.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. 3M; Scotchcast Polyolefin Fibers 2".
 - b. Euclid Chemical Company (The), an RPM company; Tuf-Strand SF.
 - c. FORTA Corporation; FORTA FERRO.
 - d. Grace Construction Products, W. R. Grace & Co.; Strux 90/40.
 - e. Nycon, Inc.; XL.
 - f. Propex Concrete Systems Corp.; Fibermesh 650.
 - g. Sika Corporation; Sika Fiber MS or MS10.

2.7 CONCRETE MIX DESIGNS

- A. Selection of Proportions: Proportions of ingredients for concrete mixes shall be determined by a qualified concrete supplier in accordance with the requirements of ACI 301.

- B. Required average strength above specified strength: Determination of required average strength above specified strength shall be based on the standard deviation record of the production facility in accordance with ACI 301. Calculation of standard deviation of compressive strength results shall be made in accordance with ACI 214. If a suitable record of strength tests is not available, proportions shall be selected on the basis of laboratory trial batches to produce an average strength greater than the strength $f'c$ by the amount defined in ACI 301.

2.8 VAPOR RETARDERS

- A. See Section 03 05 80.

2.9 FLOOR AND SLAB TREATMENTS

- A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 8 sieve.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Anti-Hydro International, Inc.; Emery.
 - b. Dayton Superior Corporation; Emery Tuff Non-Slip.
 - c. Lambert Corporation; EMAG-20.
 - d. L&M Construction Chemicals, Inc.; Grip It.
 - e. Metalcrete Industries; Metco Anti-Skid Aggregate.
- B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Anti-Hydro International, Inc.; A-H Alox.
 - b. BASF Construction Chemicals - Building Systems; Frictex NS.
 - c. L&M Construction Chemicals, Inc.; Grip It AO.

2.10 LIQUID FLOOR TREATMENTS

- A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ChemMasters; Chemisil Plus.
 - b. ChemTec Int'l; ChemTec One.
 - c. Conspec by Dayton Superior; Intraseal.
 - d. Curecrete Distribution Inc.; Ashford Formula.
 - e. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
 - f. Edoco by Dayton Superior; Titan Hard.

- g. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
 - h. Kaufman Products, Inc.; SureHard.
 - i. L&M Construction Chemicals, Inc.; Seal Hard.
 - j. Meadows, W. R., Inc.; LIQUI-HARD.
 - k. Metalcrete Industries; Floorsaver.
 - l. Nox-Crete Products Group; Duro-Nox.
 - m. Symons by Dayton Superior; Buff Hard.
 - n. US SPEC, Division of US Mix Products Company; US SPEC Industraseal.
 - o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear.
- C. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Advanced Floor Products; Retro-Plate 99.
 - b. L&M Construction Chemicals, Inc.; FGS Hardener Plus.
 - c. QuestMark, a division of CentiMark Corporation; DiamondQuest Densifying Impregnator Application.

2.11 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
 - b. BASF Construction Chemicals - Building Systems; Confilm.
 - c. ChemMasters; SprayFilm.
 - d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; Vapor-Aid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-CON.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; MONOFILM.
 - n. Sika Corporation; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; PRO-FILM.
 - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. BASF Construction Chemicals - Building Systems; Kure 200.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec by Dayton Superior; W.B. Resin Cure.
 - e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
 - f. Edoco by Dayton Superior; Res X Cure WB.
 - g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
 - h. Kaufman Products, Inc.; Thinfilm 420.
 - i. Lambert Corporation; AQUA KURE - CLEAR.
 - j. L&M Construction Chemicals, Inc.; L&M Cure R.
 - k. Meadows, W. R., Inc.; 1100-CLEAR.
 - l. Nox-Crete Products Group; Resin Cure E.
 - m. Right Pointe; Clear Water Resin.
 - n. SpecChem, LLC; Spec Rez Clear.
 - o. Symons by Dayton Superior; Resi-Chem Clear.
 - p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
 - q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Construction Chemicals - Building Systems; Kure 1315.
 - b. ChemMasters; Polyseal WB.
 - c. Conspec by Dayton Superior; Sealcure 1315 WB.
 - d. Edoco by Dayton Superior; Cureseal 1315 WB.
 - e. Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; LusterSeal WB 300.
 - f. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
 - g. Lambert Corporation; UV Safe Seal.
 - h. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - i. Meadows, W. R., Inc.; Vocomp-30.
 - j. Metalcrete Industries; Metcure 30.
 - k. Right Pointe; Right Sheen WB30.
 - l. Symons by Dayton Superior; Cure & Seal 31 Percent E.
 - m. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.
 - 2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.12 RELATED MATERIALS

- A. Expansion and Isolation Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

- B. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.13 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

2.14 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, as indicated in Structural General Notes.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.15 NON-SHRINK GROUT

- A. Grout shall be prepackaged, non metallic, and non gaseous. It shall be non-shrink when tested in accordance with ASTM-C1107 Grade B or C at a fluid consistency (flow cone) of 20 to 30 seconds. Thirty-minute-old grout shall flow through the flow cone after slight agitation, in temperatures of 40 degrees to 90 degrees Fahrenheit. Grout shall be bleed free and attain 7,500 psi compressive strength in 28 days at fluid consistency. Certified independent test data required. Approved products include the following:
 - 1. "Euco NS" by Euclid Chemical Company
 - 2. "Masterflow 713" by Master Builders.

2.16 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Proportion normal-weight concrete mixture as indicated in Structural General Notes:

2.17 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.18 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. See Section 03 10 00.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 2. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

- A. See Section 03 10 00.

3.4 SHORES AND RESHORES

- A. See Section 03 10 00.

3.5 VAPOR RETARDERS/BARRIERS

- A. See Section 03 05 80.

3.6 STEEL REINFORCEMENT

- A. See Section 03 20 00

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are specified or otherwise indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Do not permit concrete to drop freely any distance greater than 10'-0" for concrete containing a high range water reducing admixture or 5'-0" for other concrete. Provide chute or tremie to place concrete where longer drops are necessary. Do not place concrete into excavations with standing water. If place of deposit cannot be pumped dry, pour concrete through a tremie with its outlet near the bottom of the place of deposit.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

- H. Hot-Weather Placement: Comply with ACI 305 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

- A. See Section 03 10 00.

3.10 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - 1. Apply scratch finish to surfaces indicated and/or to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated and/or to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces indicated and/or exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 - 2. Finish surfaces according to ASTM E 1155, for a randomly trafficked floor surface.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated or where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive granules over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
 2. After broadcasting and tamping, apply float finish.
 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive granules.

3.11 Concrete Floor Finish Tolerances

- A. Interior Finish Floor surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155, "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System." The following values apply before removal of shores. Levelness values F(L) do not apply to intentionally sloped or cambered areas, nor to slabs poured on metal deck or precast concrete.
1. Exposed, vinyl tiled, or thin-set tiled floors: Specified overall values of flatness, Ff =35; and levelness, FI =25; with minimum local values of flatness, Ff =24; and levelness, FI =17.
 2. Carpeted floors, floors under concrete toppings, thickset tile and terrazzo: Specified overall values of flatness, Ff =25; and levelness, FI = 20; with minimum local values of flatness, Ff =17; and levelness, FI =15.
- B. Floor Elevation Tolerance Envelope:
1. The acceptable tolerance envelope for absolute elevation of any point on the slab surface, with respect to the elevation shown on the Drawings, is as follows:
 - a. Slab-on-Grade, or Slab-on-Void Construction: +/- 3/4"
 - b. Top surfaces of formed slabs measured prior to removal of supporting shores: +/- 3/4"
 - c. Top surfaces of all other slabs: +/- 3/4"
 - d. Slabs specified to slope shall have a tolerance from the specified slope of 3/8" in 10'-0" at any point, up to 3/4" from theoretical elevation at any point.

3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to

heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

- a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturers written instructions.
 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Do not apply to concrete that is less than 28 days' old.
 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.
 1. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match approved mockup.
 2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
 3. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
 4. Control and dispose of waste products produced by grinding and polishing operations.
 5. Neutralize and clean polished floor surfaces.
- C. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least six month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

- C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer

- according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.17 FIELD QUALITY CONTROL

- A. Testing and Inspecting: See Section 01 45 23.
1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 2. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

04 21 00

ARCHITECTURAL FACE BRICK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing architectural face brick assemblies, including:
 - 1. Brick Units.
 - 2. Mortar and Grout for Brick
 - 3. Brick anchors and accessories.

1.3 RELATED WORK

- A. Related Work of Other Sections.
 - 1. Division 01 Section – Testing Laboratory Services.
 - 2. Division 03 Section – Cast-in-Place Concrete.
 - 3. Division 05 Section – Structural Steel: Shelf angles and structural supports built into masonry work.
 - 4. Division 05 Section – Metal Fabrications.
 - 5. Division 07 Section – Fluid-Applied Membrane Weather Barriers.
 - 6. Division 07 Section – Building Insulation.
 - 7. Division 07 Section – Joint Sealants.
 - 8. Division 08 Section – Steel Doors and Frames.
 - 9. Division 08 Section – Entrances and Storefront.
 - 10. Division 09 Section – Gypsum Board Systems: Exterior gypsum sheathing.

1.4 REFERENCES

- A. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM C 216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
- C. ASTM C 652 – 19b – Standard Specification for Hollow Brick (Hollow Masonry Units made from Clay or Shale).
- D. ASTM D 1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

1.5 SUBMITTALS

- A. Face Brick Samples: Prior to placing orders for clay masonry units, submit at least 3 samples of each type of unit required showing full range of size, color, texture, and defects to be expected in the completed work.
- B. Mortar Selector: Prior to placing orders for clay masonry units, submit at least 3 Mortar

Selectors showing range of standard colors available for use in the completed work.

- C. Prior to placing orders for Portland cement, provide certified test results showing compliance with requirements, including compliance with the low-alkali requirements.
- D. Submit product data for each type of face brick and masonry work accessory.

1.6 QUALITY ASSURANCE

- A. A. Materials:
 - 1. Face Brick: Obtain face brick of uniform texture and color, or uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.
 - 2. Mortar: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.
- B. On-Site Mock-Up: Build an on-Site mock-up as indicated by architect to establish a standard for materials and workmanship for the remainder of the work. Upon acceptance of mock-up by Owner, Construction Manager, and Architect, place order for clay masonry units.
- C. Pre-Installation Conference: Prior to start of masonry work, meet at Project Site with installer ("Mason"), and representatives of other entities directly concerned with performance of masonry work including test agencies, governing authorities, product manufacturers, Architect, Construction Manager, and Owner.
 - 1. Review requirements (Contract Documents), submittals, status of coordinating work, availability of materials and installation facilities, proposed installation schedule, requirements for inspections and testing, forecasted weather conditions, and proposed installation procedures.
 - 2. Record discussion including agreement or disagreement on matters of significance; furnish copy of recorded discussions to each participant.
 - 3. Discuss masonry protection requirements for construction period extending beyond masonry completion.
 - 4. If meeting ends with substantial disagreements, determine how disagreement will be resolved and set date for reconvened meeting.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store face brick on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location Do not use cementitious materials that have become damp.
- C. Store aggregates where grading can be maintained and contamination avoided.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend covers minimum 24" down both sides of wall and hold securely in place. Where one wythe of multi-wythe masonry is completed in advance of other wythes, secure cover a minimum 24" down face next to unconstructed wythe and hold cover in place.
 - 2. Stain Prevention: Prevent grout, mortar, and soil from staining masonry surfaces

- exposed to view or scheduled to be painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
3. Cold-Weather Protection Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace masonry damaged by frost or freezing conditions. Comply with cold weather construction requirements as prescribed by codes in force.
 4. Hot-Weather Protection Requirements: Protect unit masonry when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade, wind breaks, and use cooled materials as required. When ambient temperature exceeds 100°F. (38°C.), or 90°F. (32°C.) with a wind greater than 8 mph (12.8-Km/hr), do not spread mortar bed greater than 48" ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Architectural Face Brick:
 1. Manufacturers:
 - a. Basis of Design:
 - 1) Acme
 - b. Other Manufacturers:
 - 1) Bilco Brick
 - 2) Belden Brick
 - 3) Meridian Brick
 2. Brick Types:
 - a. Velour Texture, Modular, TUP002 color or equivalent by other manufacturer.
 3. Special Shapes as indicated and detailed in Drawings.
 - a. Furnish special, uncured face brick in locations where cores would be exposed to finish work.
- B. Mortar and Grout:
 1. Low Alkali Portland Cement: ASTM C 150, low alkali type with not more than 0.60% water-soluble alkali. Provide Type I, except Type III may be used for setting masonry during cold weather. Subject to compliance with requirements, provide TXI Cement Company, New Braunfels, TX, (Tel) 512-396-4244, Type I low alkali Portland cement, or approved equivalent. Do not use masonry cement.
 2. Mortar Mix: Provide Portland cement-lime mortar complying with ASTM C 270, Type S mortar mix (1800 psi) for reinforced unit masonry work and Type N mortar mix (750 psi) for veneer masonry. Provide mortar mix consisting of low alkali Portland cement (ASTM C 150, Type I) as specified, lime (ASTM C 207, Type S), clean sand (ASTM C 144, with not less than 100% passing a No. 8 sieve), coloring and water for workable mix. Do not use masonry cement.
 - a. Mortar Color: Standard gray Portland cement-lime mortar to match approved sample.
 3. Grout: Provide grout complying with ASTM C 476, Type PL, with a minimum 28- day compressive strength of 2,500 psi. Grout shall consist of low alkali Portland cement, aggregates (fine or coarse as follows) and water to produce a consistency at time of placement that will completely fill all spaces intended to receive grout. Do not use masonry cement. Use fine grout in grout spaces less than 2" in least horizontal dimension and coarse grout in spaces 2" or more in least horizontal dimension. Do not use mortar in place of grout.
- C. Accessories: Provide standard hot-dipped galvanized anchors and accessories for exterior locations and mill galvanized anchors and accessories at interior locations.

1. Anchors: "HB-213 Adjustable Veneer Anchor" By Hohmann & Barnard, Inc., or equivalent by Wire-Bond, or Heckmann.
2. Concealed Masonry Flashing: "C-Coat Flashing" by Hohmann & Barnard, Inc., or equivalent by AFCO Products, Polyrite Manufacturing Corp., Sandell Manufacturing Co., or York Manufacturing, Inc.
3. Masonry Flashing Drip-Edge: Hohmann & Barnard FTSA Drip Plate, or equivalent.
4. Reinforcing Bars:
 - a. Types as recommended by masonry manufacturer.
5. Compressible Filler: Hohmann & Barnard "No. NS," 3/8" thick, or equivalent by Dur-O-Wal.
6. Bond Breakers: Asphalt saturated organic felt, ASTM D 226, Type I, No. 15.
7. Masonry Cleaners: ProSoCo, Inc., Kansas City, MO, "Sure Klean 600" general purpose detergent cleaner, "Sure Klean 101 Lime Solvent" for removal of excess mortar and job stains, and "White Scum Remover" for removal of insoluble salt scums from mortar, or equivalent cleaners formulated to be safe on masonry and non-masonry surfaces such as anodized aluminum, painted surfaces and similar finishes.
8. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard; Mortar Net USA, Ltd.; Mortar Net Weep Vents.
9. Drill Screw Fasteners for Screw Attached Masonry Veneer Anchors and Ties: ASTM C 954, except with hex washer head and neoprene washer, No. 10 by length require to penetrate steel stud flange by not less than three exposed threads, and with organic polymer coating complying with ASTM B 117; "Traxx" by ITW-Buildex or "Dril-Flex" by Elco Industries.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 LAYOUT OF MASONRY WORK

- A. Layout walls in advance for accurate spacing of surface bond patterns, to provide uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corner, jambs, and wherever possible at other locations.
- B. Notify architect of any opening locations that conflict with brick coursing, in either horizontal or vertical dimensions.

3.3 MASONRY INSTALLATION

- A. Lay-up exterior clay masonry unit work in bond indicated in exterior elevations.
- B. Laying Masonry General:
 1. Lay brick making sure head joints and bed joints are full of mortar.
 2. Lay brick units plumb and true to line.
 3. Where fresh mortar joins partially set mortar, remove loose brick and mortar and lightly wet the exposed surface of set masonry.
 4. When adjustment must be made after mortar begins to harden, remove hardened mortar and replace it with fresh mortar.
 5. Remove excess mortar as Work progresses.

- C. Masonry Reinforcing and Anchors: Install as indicated and in accordance with the reinforcing manufacturer's requirements.
- D. Fabricated Steel Lintels: Install as indicated in Structural Drawings.
- E. Joints Tooling and Pointing:
 - 1. If not otherwise indicated, lay walls with 3/8" joints.
 - a. Maintain joint widths shown, except for minor variations required to maintain bond alignment.
 - 2. Tool mortar joints to shape(s) indicated on the Drawings.
 - a. If not otherwise indicated in the Drawings, provide standard Concave joint.
 - 3. Tool exposed joints when they are thumbprint hard.
 - 4. Flush-cut all joints when they are not tooled, and at locations that are to be concealed or covered by other materials.
 - 5. When re-pointing a section in a wall, rake the mortar joints to a depth of not less than 1/2 inch. Fill the joint completely with pointing mortar and tool to match the surrounding masonry.
- F. Flashing:
 - 1. Build in all flashings that enter the masonry, as the work progresses. Install as indicated and as specified in Section 07 62 00 - Sheet Metal Flashing and Trim.
 - 2. Remove any projections on the brick surface or mortar bed that might puncture the flashing material.
 - 3. Place through-wall flashing on a bed of mortar so that the flashing projects 1/4 inch from wall face and forms a drip edge. Overlap flashing a minimum of 6 inches.
 - 4. Cover flashing with mortar.
- G. Weeps:
 - 1. Install weeps in the head joints of the first brick course immediately above the through-wall flashing. Place weeps at not more than 24 inches on center horizontally.
 - 2. Keep the air cavity free of mortar as much as possible. Expansion Joints:
- H. Control And Expansion Joints:
 - 1. Install control and expansion joints as indicated on Drawings.
 - 2. Keep joints free of mortar and any debris that may hinder movement.
 - 3. Install expansion joint material and finish the joint with a sealer.
- I. Cleanouts for Grouting: Provide clean-outs in cells to be grouted at maximum 5- foot centers, vertically. Remove excess mortar by "rodding" and with compressed air. After cleaning cells to be grouted, close clean-outs with masonry to match adjacent construction. Do not place grout until entire height of masonry has attained sufficient strength to resist grout pressure. Place grout in such a way as to prevent segregation of materials. Pour grout fluid enough to flow into all crevices of grout spaces leaving no voids.
 - 1. Cutting and Patching: Provide full size units matching existing adjacent construction for size, texture, bond, and joint profile. Perform repairs so that repaired area is relatively imperceptible in the completed Work.
- J. Laying Masonry: Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove in place. Do not slush head joints.
- K. Stopping and Resuming Work: In each course, rack back 1/2 unit length for running bond or 1/3 unit length for one-third running bond; do not tooth except at repairs in existing construction. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.

- L. Correction of Damaged Masonry: Remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as required. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.

3.4 CLEANING AND PROTECTION

- A. Cleaning Brick: Clean exposed brick units by dry brushing at the end of each days work and after final pointing to remove mortar spots and droppings. Comply with Brick Industry Association Technical Note 20 (June 2006) *Cleaning Brickwork*.
- B. Protection of Brick: Protect partially completed masonry against weather at the end of each day's work and when work is not in progress, by covering top of walls with strong, waterproof, non-staining membrane. Extend membrane at least 24" down both sides of walls and hold cover securely in place. Protect bases of walls from mud, mortar and other stains. Where cutting, forming, welding and similar operations must be performed near or above masonry work, provide substantial protection against damage.

3.5 FIELD QUALITY CONTROL

- A. Test and evaluate each 5,000 sq. ft. or grouted reinforced masonry work, or fraction thereof, as follows:
 - 1. Mortar Compressive Strength: Provide sampling and testing in accordance with ASTM C 780.
 - 2. Grout Compressive Strength: Provide sampling and testing in accordance with ASTM C 1019.
- B. Evaluation of Quality Control Tests: In the absence of other indications of noncompliance, masonry will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

END OF SECTION

04 22 00

CONCRETE MASONRY UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing unit masonry assemblies, including:
 - 1. Concrete masonry units, including masonry lintels, bond beams, flashings, and related work.
 - 2. Portland cement-lime mortar.
 - 3. Grouted reinforced masonry work as indicated.
 - 4. Cleaning masonry work.

1.3 RELATED WORK

- A. Related Work of Other Sections.
 - 1. Division 01 Section – Testing Laboratory Services.
 - 2. Division 03 Section – Cast-in-Place Concrete.
 - 3. Division 05 Section – Structural Steel: Shelf angles and structural supports built into masonry work.
 - 4. Division 05 Section – Metal Fabrications.
 - 5. Division 07 Section – Fluid-Applied Membrane Weather Barriers.
 - 6. Division 07 Section – Building Insulation.
 - 7. Division 07 Section – Joint Sealants.
 - 8. Division 08 Section – Steel Doors and Frames.
 - 9. Division 08 Section – Entrances and Storefront.
 - 10. Division 09 Section – Gypsum Board Systems: Exterior gypsum sheathing.

1.4 REFERENCES

- A. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM C90 – Standard Specification for Loadbearing Concrete Masonry Units.
- C. ASTM D 1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

1.5 SUBMITTALS

- A. Prior to placing orders for Portland cement, provide certified test results showing compliance with requirements, including compliance with the low-alkali requirements.
- B. Submit product data for each type of concrete masonry unit and masonry work accessory.

1.6 QUALITY ASSURANCE

- A. Pre-Installation Conference: Prior to start of masonry work, meet at Project Site with installer ("Mason"), and representatives of other entities directly concerned with performance of masonry work including test agencies, governing authorities, product manufacturers, Architect, Construction Manager, and Owner.
 - 1. Review requirements (Contract Documents), submittals, status of coordinating work, availability of materials and installation facilities, proposed installation schedule, requirements for inspections and testing, forecasted weather conditions, and proposed installation procedures.
 - 2. Record discussion including agreement or disagreement on matters of significance; furnish copy of recorded discussions to each participant.
 - 3. Discuss masonry protection requirements for construction period extending beyond masonry completion.
 - 4. If meeting ends with substantial disagreements, determine how disagreement will be resolved and set date for reconvened meeting.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store concrete masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location Do not use cementitious materials that have become damp.
- C. Store aggregates where grading can be maintained and contamination avoided.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend covers minimum 24" down both sides of wall and hold securely in place. Where one wythe of multi-wythe masonry is completed in advance of other wythes, secure cover a minimum 24" down face next to unconstructed wythe and hold cover in place.
 - 2. Stain Prevention: Prevent grout, mortar, and soil from staining masonry surfaces exposed to view or scheduled to be painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 3. Cold-Weather Protection Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace masonry damaged by frost or freezing conditions. Comply with cold weather construction requirements as prescribed by codes in force.
 - 4. Hot-Weather Protection Requirements: Protect unit masonry when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade, wind breaks, and use cooled materials as required. When ambient temperature exceeds 100°F. (38°C.), or 90°F. (32°C.) with a wind greater than 8 mph (12.8-Km/hr), do not spread mortar bed greater than 48" ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete Masonry Units:
 - 1. Lightweight Concrete Masonry Units (CMU-1): ASTM C 90, Lightweight, Type I,

- moisture controlled units in sizes indicated. Conform to UL requirements at all fire-rated masonry construction. Provide sash block units at control joints and continuous control joint filler.
2. Special Shapes (CMU-04): Provide lintels, bullnose units for outside corners, jambs, control joints, window sill units, solid copings and other conditions indicated. Provide U-shaped lintel blocks with solid bottoms over window and door openings. Provide straight internal corners and straight units at all base locations.
- B. Mortar and Grout:
1. Low Alkali Portland Cement: ASTM C 150, low alkali type with not more than 0.60% water-soluble alkali. Provide Type I, except Type III may be used for setting masonry during cold weather. Subject to compliance with requirements, provide TXI Cement Company, New Braunfels, TX, (Tel) 512-396-4244, Type I low alkali Portland cement, or approved equivalent. Do not use masonry cement.
 2. Mortar Mix: Provide Portland cement-lime mortar complying with ASTM C 270, Type S mortar mix (1800 psi) for reinforced unit masonry work and Type N mortar mix (750 psi) for veneer masonry. Provide mortar mix consisting of low alkali Portland cement (ASTM C 150, Type I) as specified, lime (ASTM C 207, Type S), clean sand (ASTM C 144, with not less than 100% passing a No. 8 sieve), coloring and water for workable mix. Do not use masonry cement.
 - a. Mortar Color: Standard gray Portland cement-lime mortar to match approved sample.
- C. Accessories: Provide standard hot-dipped galvanized anchors and accessories for exterior locations and mill galvanized anchors and accessories at interior locations.
1. Anchors:
 - a. Types as recommended by masonry manufacturer.
 2. Concealed Masonry Flashing: "C-Coat Flashing" by Hohmann & Barnard, Inc., or equivalent by AFCO Products, Polytite Manufacturing Corp., Sandell Manufacturing Co., or York Manufacturing, Inc.
 3. Masonry Flashing Drip-Edge: Hohmann & Barnard FTSA Drip Plate, or equivalent.
 4. Reinforcing Bars:
 - a. Types as recommended by masonry manufacturer.
 5. Compressible Filler: Hohmann & Barnard "No. NS," 3/8" thick, or equivalent by Dur-O-Wal.
 6. Bond Breakers: Asphalt saturated organic felt, ASTM D 226, Type I, No. 15.
 7. Masonry Cleaners: ProSoCo, Inc., Kansas City, MO, "Sure Klean 600" general purpose detergent cleaner, "Sure Klean 101 Lime Solvent" for removal of excess mortar and job stains, and "White Scum Remover" for removal of insoluble salt scums from mortar, or equivalent cleaners formulated to be safe on masonry and non-masonry surfaces such as anodized aluminum, painted surfaces and similar finishes.
 8. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard; Mortar Net USA, Ltd.; Mortar Net Weep Vents.
 9. Drill Screw Fasteners for Screw Attached Masonry Veneer Anchors and Ties: ASTM C 954, except with hex washer head and neoprene washer, No. 10 by length require to penetrate steel stud flange by not less than three exposed threads, and with organic polymer coating complying with ASTM B 117; "Traxx" by ITW-Buildex or "Dril-Flex" by Elco Industries.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with installer present, for compliance with requirements for installation

tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 LAYOUT OF MASONRY WORK

- A. Layout walls in advance for accurate spacing of surface bond patterns, to provide uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corner, jambs, and wherever possible at other locations.
- B. Notify architect of any opening locations that conflict with Concrete Masonry Unit coursing, in either horizontal or vertical dimensions.

3.3 MASONRY INSTALLATION

- A. Lay-up exterior concrete masonry unit work in bond indicated in exterior elevations.
- B. Laying Masonry General:
 - 1. Lay concrete masonry units making sure head joints and bed joints are full of mortar.
 - 2. Lay concrete masonry units plumb and true to line.
 - 3. Where fresh mortar joins partially set mortar, remove loose concrete masonry unit and mortar and lightly wet the exposed surface of set masonry.
 - 4. When adjustment must be made after mortar begins to harden, remove hardened mortar and replace it with fresh mortar.
 - 5. Remove excess mortar as Work progresses.
- C. Masonry Reinforcing and Anchors: Install as indicated and in accordance with the reinforcing manufacturer's requirements.
- D. Fabricated Steel Lintels: Install as indicated in Structural Drawings.
- E. Control And Expansion Joints:
 - 1. Install control and expansion joints as indicated on Drawings.
 - 2. Keep joints free of mortar and any debris that may hinder movement.
 - 3. Install expansion joint material and finish the joint with a sealer.
- F. Cleanouts for Grouting: Provide clean-outs in cells to be grouted at maximum 5- foot centers, vertically. Remove excess mortar by "rodding" and with compressed air. After cleaning cells to be grouted, close clean-outs with masonry to match adjacent construction. Do not place grout until entire height of masonry has attained sufficient strength to resist grout pressure. Place grout in such a way as to prevent segregation of materials. Pour grout fluid enough to flow into all crevices of grout spaces leaving no voids.
 - 1. Cutting and Patching: Provide full size units matching existing adjacent construction for size, texture, bond, and joint profile. Perform repairs so that repaired area is relatively imperceptible in the completed Work.
- G. Laying Masonry: Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove in place. Do not slush head joints.
- H. Stopping and Resuming Work: In each course, rack back 1/2 unit length for running bond or 1/3 unit length for one-third running bond; do not tooth except at repairs in existing construction. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.
- I. Correction of Damaged Masonry: Remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as

required. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.

3.4 CLEANING AND PROTECTION

- A. Cleaning Concrete Masonry Units: Clean exposed concrete masonry units by dry brushing at the end of each days work and after final pointing to remove mortar spots and droppings. Comply with NCMA Bulletin No. 28.
- B. Protection of Masonry Work: Protect partially completed masonry against weather at the end of each day's work and when work is not in progress, by covering top of walls with strong, waterproof, non-staining membrane. Extend membrane at least 24" down both sides of walls and hold cover securely in place. Protect bases of walls from mud, mortar and other stains. Where cutting, forming, welding and similar operations must be performed near or above masonry work, provide substantial protection against damage.

3.5 FIELD QUALITY CONTROL

- A. Test and evaluate each 5,000 sq. ft. or grouted reinforced masonry work, or fraction thereof, as follows:
 - 1. Mortar Compressive Strength: Provide sampling and testing in accordance with ASTM C 780.
 - 2. Grout Compressive Strength: Provide sampling and testing in accordance with ASTM C 1019.
- B. Evaluation of Quality Control Tests: In the absence of other indications of noncompliance, masonry will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

END OF SECTION

04 70 00

CAST STONE MASONRY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
1. Cast stone exterior coping caps set with stone anchors.
 2. Cast stone exterior window sills set with stone anchors.
 3. Sealant joints at all cast stone joints. Sealant work is specified in Section 07 29 00.
 4. Decorative Cast Stone Masonry Units.

1.3 RELATED WORK

- A. Related Work of Other Sections:
1. Section 04 20 00 – Unit Masonry Veneer.
 2. Section 05 40 00 – Cold Formed Metal Framing.
 3. Section 05 50 00 – Metal Fabrications.
 4. Section 07 42 13 – Metal Wall Panels.
 5. Section 07 92 00 – Joint Sealants.
 6. Section 08 41 13 – Entrances and Storefronts.
 7. Section 09 24 00 – Plaster Assemblies.
 8. Section 09 21 16 – Gypsum Board Assemblies.

1.4 SUBMITTALS

- A. Shop Drawings: Submit copies of cutting and setting drawings, showing cast stone construction, including stone profiles and thickness, details of all lifting devices, joinery details, anchorage, supports, bracing, sealing methods, stone finishes, location of all joints, work to be performed by other trades which adjoins, penetrates or is secured to stonework and all other pertinent information. Indicate location of each cast stone unit on setting drawings with number designation corresponding to number marked on each unit.
- B. Product Data: Submit product data and samples of each type of cast stone accessory.
- C. Samples:
1. Prior to placing orders for cast stone, submit at least 3 samples of each type of cast stone required showing range of, color, texture, and defects to be expected in the completed work.
 2. Prior to placing orders for Portland cement, provide certified test results showing compliance with requirements, including compliance with the low-alkali requirements.
- D. Mock-Up Sample Installation:
1. Prior to installation of cast stone, fabricate sample panels of each type of cast stone unit with proposed range of color, texture and workmanship to be expected in the

- completed Work. Build mock-up at Site, as directed, using cast stone and jointing, as shown and specified and in accordance with approved shop drawings.
2. Obtain Architect's approval of visual qualities of the sample panels. Replace unsatisfactory mock-up work, as directed, until acceptable to Architect. Retain sample panels during construction as a standard for judging completed cast stone. Do not alter, move or destroy mock-up until Work is completed or when directed by Architect.
 3. Where sealant primers, sealants, and other compounds are required in the finished stonework, build mock-up and apply compounds in sufficient time to allow for final test for staining or other deleterious effects from such applications.

1.5 QUALITY ASSURANCE

- A. Qualifications of Fabricator: Only a firm which has had a minimum of 5-years successful experience in the design and fabrication of cast stone similar to cast stone required for this Project will be acceptable. Fabricator must have sufficient production capacity to design, fabricate, transport and deliver required cast stone anchorage and support work without causing delay in the Work. Fabricate cast stone only at a plant engaged in producing similar units.
- B. Qualifications of Installer: Only a firm which has had a minimum of 2-years successful experience in setting cast stone work similar to work required for this Project will be acceptable.
- C. Dimension Coordination: Coordinate and verify by measurement at the Project Site, dimensions affecting cast stone and related work. Submit written notification of field dimensions and conditions which vary from requirements indicated on the Drawings, approved shop drawings, or are detrimental to proper and timely installation of related work. Where conflicts occur, obtain determination from Architect prior to fabrication of cast stone items in work area affected.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Handle cast stone to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of cast stone with wood or other rigid materials. Lift with wide-belt type slings wherever possible; do not use wire rope or ropes containing tar or other substances that might cause staining. If required, use wood rollers and provide cushion at end of wood slides.
- B. Store cast stone on wood skids or pallets; distribute weight evenly and to prevent breakage or cracking of stones. Protect stored cast stone from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around stones.
- C. Cold Weather Protection:
 1. Remove ice or snow formed on cast stone bed by carefully applying heat until top surface is dry to touch.
 2. Remove cast stone work determined to be damaged by freezing conditions.
 3. During all seasons, protect partially completed cast stone work against weather when work is not in progress. Cover top of walls with strong waterproof, nonstaining membrane extending at least 2' down both sides of walls and anchor securely in place.

PART 2 PRODUCTS

2.1 CAST STONE

- A. Provide cast stone units in color, texture, profiles, and dimensions to match approved

samples. Refer to Finish Legend and Elevations for material selections, colors, textures, and profiles, shapes, and sizes required.

- B. Provide steam-cured units of uniform dimensions and texture, straight and free of cracks, spalls and other visible defects.
- C. Provide mix for cast stone units composed of Portland cement, ASTM C 150, Type I, aggregate of type, color and size and as required to match approved samples, and concrete color as required to match approved samples. Test aggregates by an independent testing laboratory for bacterial growth. Aggregates that will support such growth will be cause for rejection. Cost for tests shall be borne by unit manufacturer.
- D. Provide deformed steel reinforcing complying with ASTM A 615, Grade 40 or 60 as required.

2.2 SETTING MATERIALS

- A. Anchor Bolts, Nuts and Washers: AISI Type 302/304 stainless steel if in contact with stone; otherwise, provide regular low carbon steel bolts and nuts (ASTM A 307) hot-dip galvanized, complying with ASTM A 153.
- B. Cast Stone Anchors and Dowels: Type and size shown or, if not shown, as required to securely anchor and fasten stonework in place. Fabricate anchors and dowels from Type 302/304 stainless steel.
- C. Setting Buttons: Lead or aluminum buttons of the thickness required for the joint size shown or specified, and of the size required to maintain uniform joint width.
- D. Through Wall Flashing, Mortar and Grout Materials: See Section 04 20 00 for requirements.

2.3 FABRICATION

- A. Fabrication: Fabricate and cure cast stone in the shop by skilled workmen to the sizes and profiles indicated. Fabricate reinforcing required and carefully locate in form to provide at least 1-1/2" of concrete cover over reinforcing. Use templates to cast-in or cut holes for anchoring devices in the completed Work.

PART 3 EXECUTION

3.1 PREPARATION AND EXAMINATION.

- A. Advise installers of other work about specific requirements relating to his placement of inserts and flashing reglets which are to be used by the stone mason for anchoring, supporting, and flashing of stonework. Furnish installers of other work with drawings or templates showing location of inserts for stone anchors and supports.
- B. Clean cast stone before setting by thoroughly scrubbing with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh fillers or abrasives. If not thoroughly wet at time of setting, drench or sponge stone.
- C. Inserts: Advise installers of other work about specific requirements relating to his placement of inserts and flashing which are to be used by the mason for anchoring, supporting, and flashing of cast stone work. Furnish installers of other work with drawings or templates showing location of inserts for cast stone anchors and supports.
- D. Examine conditions, with installer present, for compliance with requirements for installation

tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 LAYOUT OF CAST STONE MASONRY WORK

- A. Layout walls in advance for accurate spacing of surface bond patterns, to provide uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of units of length/width less than depth at corner, jambs, and wherever possible at other locations.
- B. Notify architect of any opening locations that conflict with cast stone masonry coursing, in either horizontal or vertical dimensions.
- C. Coordinate cast stone coursing and clay masonry (brick) coursing. Wherever possible, cast stone joints shall align to brick joints adjacent.

3.3 GENERAL CAST STONE INSTALLATION

- A. Install cast stone using skilled mechanics, and employ skilled masons.
- B. Where cast stone will contact ferrous metal surfaces which will be concealed in back-up construction (anchors, supports, structural framing and similar surfaces), use only anchors and support fabricated of AISI Type 302/304 stainless steel.
- C. Provide expansion joints where shown in drawings; or at not less than 25' on center (whichever is less) and aligning with expansion joints in adjacent wall finishes. Do not fill with setting materials. Install continuous strips of preformed joint filler to allow for installation of backer rod and sealant, specified in Section 07 92 00.
- D. Set cast stone in accordance with Drawings and final shop drawings for cast stone. Provide anchors, supports, fasteners and other attachments shown, or necessary to secure cast stone in place. Shim and adjust accessories for proper setting of cast stone.
- E. Exterior Cavity Construction: Where open space between back of cast stone units and back-up or framing is shown, keep cavity open; do not fill with mortar or grout.

3.4 SPECIAL INSTALLATION REQUIREMENTS OF CAST STONE MASONRY UNITS.

- A. Lay-up exterior cast stone masonry unit work in bond indicated in exterior elevations.
- B. Laying Masonry General:
 - 1. Lay cast stone masonry units making sure head joints and bed joints are full of mortar.
 - 2. Lay cast stone units plumb and true to line.
 - 3. Where fresh mortar joins partially set mortar, remove loose cast stone and mortar and lightly wet the exposed surface of set masonry.
 - 4. When adjustment must be made after mortar begins to harden, remove hardened mortar and replace it with fresh mortar.
 - 5. Remove excess mortar as Work progresses.

3.5 ADJUSTING AND CLEANING

- A. Remove and replace cast stone units that are broken, chipped, stained, or otherwise damaged. Where directed, remove and replace units that do not match adjoining cast stone work. Provide new matching units, install as specified and point-up joints to eliminate evidence of replacement. Repoint defective and unsatisfactory joints as required to provide a neat, uniform appearance.

- B. Clean cast stone not less than 6 days after completion of work, using clean water and stiff-bristle brushes. Do not use wire brushes, acid type cleaning agents or other cleaning compounds with caustic or harsh fillers.

END OF SECTION

05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Miscellaneous framing and supports for the following:
 - a. Louvers.
 - b. Lavatory counters.
 - c. Metal pan steel stairs and platforms.
 - d. Steel pipe handrails.
 - e. Steel ladders and supports.
 - f. Applications where framing and supports are not specified in other sections.
 2. Shelf and relieving angles.
 3. Alternating-tread stairs
 4. Miscellaneous steel trim.
 5. Pipe bollards.
 6. Loose bearing and leveling plates.
 7. Loose steel lintels.
 8. Rough hardware.
 9. Heavy duty metal bar gratings and frames for trench drains.
 10. Prefabricated metal framing.
- B. Products furnished, but not installed, under this Section:
1. Loose steel lintels.
 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
- C. Related Sections:
1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
 2. Section 04 21 00 "Face Brick" for installing loose lintels, anchor bolts, and other items built into face brick.
 3. Section 04 22 10 "Decorative Concrete Masonry" for installing loose lintels, anchor bolts and other items built into decorative concrete masonry.
 4. Section 04 70 00 "Cast Stone Masonry" for installing loose lintels, anchor bolts, and other items built into cast stone masonry.
 5. Section 05 12 00 "Structural Steel Framing" for structural steel framing including elevator machine support beams, hoist beams, and divider beams.
 6. Section 06 10 00 "Rough Carpentry" for metal framing anchors.
 7. Section 14 24 00 "Hydraulic Elevators."

1.3 REFERENCES

- A. Comply with the provisions of the following codes, standards and specifications, except as otherwise shown and specified.
1. AISC: Follow AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", including "Commentary of the AISC Specifications".
 2. AISI: Follow AISI "Specifications for the Design of Cold-Formed Steel Structural Members".
 3. ASTM: Follow ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
 4. AWS: Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" and D1.3 "Structural Welding Code – Sheet Steel". Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 PERFORMANCE REQUIREMENTS

- A. Fabrication Workmanship: Provide the following classes of workmanship for miscellaneous metal fabrication items indicated or required.
1. Class 1 Workmanship: Items that are exposed to view in finished spaces in completed Work.
 - a. Exposed Surfaces: Sandblast surfaces smooth; grind off mill marks; fill nicks and scratches so that defects do not show when painted. Remove sharp corners and edges.
 - b. Welds: Conceal welds where possible. Where exposed, grind welds to small radius with uniform sized cove. When painted, welds shall be undetectable.
 - c. Bolts: Use only flat head countersunk bolts in exposed locations.
 - d. Straightness: Distortions visible to the eye will be rejected.
 - e. Joints: Fit joints to hairline finish.
 2. Class 2 Workmanship: Items that are exposed to view in utility areas of the completed Work.
 - a. Exposed Surfaces: Moderate irregularities not visible at 30-feet (9 m) may remain. Mill marks may remain. Remove sharp corners and edges.
 - b. Welds: Provide neat welds of uniform size. Remove splatter and protrusions.
 - c. Bolts: Use only flat or oval head, countersunk bolts where exposed to view.
 - d. Straightness: Minor distortions not exceeding 1/8-inch (3 mm) in 8'-0" (2.4 m) will be permitted.
 - e. Joints: Provide maximum gap of 1/16-inch (1.5 mm).
 3. Class 3 Workmanship: Items that are concealed from view in the completed Work.
 - a. Exposed Surfaces: Mill finish with surface preparation for galvanizing or priming.
 - b. Welds: Grinding not required.
 - c. Bolts: Exposed bolts permitted.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Nonslip aggregates and nonslip-aggregate surface finishes.
 2. Prefabricated building columns.
 3. Metal nosings and treads.

- 4. Paint products.
 - 5. Grout.

 - B. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

 - C. Samples for Verification: For each type and finish of extruded nosing.

 - D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For qualified professional engineer.

 - B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

 - C. Welding certificates.

 - D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- 1.7 QUALITY ASSURANCE
- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2, "Structural Welding Code - Aluminum."
- 1.8 PROJECT CONDITIONS
- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.
- 1.9 COORDINATION
- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

 - B. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Rolled-Steel Floor Plate: ASTM A 786 rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.
- C. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- D. Steel Pipe: ASTM A 53, standard weight (Schedule 40) unless otherwise indicated.
- E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches unless otherwise required for loads supported.
 - 2. Material: Galvanized steel, ASTM A 653, commercial steel, Type B, with G90 coating; 0.108-inch nominal thickness.
- F. Cast Iron: Either gray iron, ASTM A 48, or malleable iron, ASTM A 47, unless otherwise indicated.

2.3 NONFERROUS METALS

- A. Aluminum Castings: ASTM B 26, Alloy 443.0-F.

2.4 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless-steel fasteners for fastening stainless steel.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A, Property Class 4.6); with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Eyebolts: ASTM A 489.
- F. Machine Screws: ASME B18.6.3.
- G. Lag Screws: ASME B18.2.1.
- H. Wood Screws: Flat head, ASME B18.6.1.
- I. Plain Washers: Round, ASME B18.22.1.
- J. Lock Washers: Helical, spring type, ASME B18.21.1.
- K. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required.
- L. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times

the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

- M. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- N. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594 .
 - 3. Drilled-in Sleeve Type Expansion Anchors: FS FF-S-325, Group II, Type 3 externally threaded stud with full-length expanding sleeve; Hilti sleeve anchor, or equivalent by Powers or Simpson.
 - 4. Drilled-in Wedge-Type Expansion Anchors: FS FF-S-325, Group II, Type 4 externally threaded stud with single-piece wedge; Hilti Kwik Bolt II, or equivalent by Powers or Simpson.
 - 5. Epoxy Adhesive Anchors for Concrete: Hilti Corp., Tulsa, OK, (Tel) 800-879-8000 or 713-462-8699, "HVA Adhesive Anchor", 3/8" x 4" long unless otherwise indicated or required for proper fastening of items indicated, or equivalent by Powers (Rawl), Ramset/Redhead, or Simpson.
- O. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Primers: Provide interior exposure primers that comply with Section 09 90 00 "Painting and Coating." and Section 09 96 00 "High-Performance Coatings." For exterior exposure primers.
- D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- G. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM

C 1107, specifically recommended by manufacturer for heavy-duty loading applications.

- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.
- J. Anti-Slip Surfacing: 3M Company "Safety-Walk", black color with adhesive recommended by manufacturer for substrates indicated.
- K. Prefabricated Metal Framing and Support Bracing: Equivalent to Unistrut hot-dip galvanized P1000H3 with P3016-1420 nuts, HHCS205075EG hex head cap screws, P1026 ninetydegree angle fittings, (2) P1358 mounting brackets near lower corners of frame, and (4) P2398S beam clamps, unless heavier sections are required to support and brace loads indicated or required by structural calculations. Provide clips of required size for direct attachment to structural steel framing members.
- L. Provide cast gratings and frames Type TGMB-10 with form pans as manufactured by McKinley Iron Works, Fort Worth, Texas, or equivalent approved by Architect. Assemble in multiples of stock lengths.

2.6 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware,

screws, and similar items.

- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
 1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports for exterior exposure with primer specified in Section 09 96 00 "High-Performance Coatings".

2.8 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
 1. Provide mitered and welded units at corners.
 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize shelf angles located in exterior walls.
- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast in-place concrete.

2.9 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.

2.10 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe, as indicated].
- B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts
 - 1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
 - 2. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch-thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than Outer Diameter of bollard.
 - 3. Galvanize bollards and sleeves after fabrication.

2.11 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.
- C. Prime plates with [zinc-rich primer.] [primer specified in Section 09 Section "High-Performance Coatings."]

2.12 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.

2.13 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 ROUGH HARDWARE

- A. Furnish custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes in the sizes, shapes and dimensions required for framing and supporting and anchoring rough carpentry. Hot-dip galvanize where exposed to atmosphere or embedded into concrete. Furnish malleable iron washers for bolt heads and nuts that bear on wood connections; elsewhere furnish steel washers.

2.15 METAL BAR GRATINGS

- A. Provide banded metal bar grating as shown on the Drawings, complying with the NAAMM "Metal Bar Grating Manual" and as specified herein. Furnish grating units complete with angle frames where indicated on the Drawings. Frames and fastening devices shall be of same material and finish as grating supported. Provide removable grating sections with endbearing bars, 4 saddle clip anchors designed to fit over 2 bearing bars, and 4 stud bolts

with washers and nuts. Notching of bearing bars at supports to maintain elevations is not acceptable. Subject to compliance with requirements, provide units produced by Borden Metal Products, IKG Industries or Reliance Steel Products.

1. Furnish grating units complete with angle frames where indicated on the Drawings. Frames and fastening devices shall be of same material and finish as grating supported.
2. Provide removable grating sections with end-bearing bars, 4 saddle clip anchors designed to fit over 2 bearing bars, and 4 stud bolts with washers and nuts. Notching of bearing bars at supports to maintain elevations is not acceptable. Subject to compliance with requirements, provide units produced by Borden Metal Products, IKG Industries or Reliance Steel Products.
3. Pressure-Locked Plain Surfaced Rectangular Steel Bar Grating: Provide I. K. G. Borden Type B pressure-locked grating with 1-1/4" (31 mm) x 3/16" (5 mm) bearing bars at 1-3/16" o.c. and crossbars at 4" (100 mm) on center, or equivalent.
4. Hot-dip galvanize completed assemblies after fabrication.

2.16 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.17 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products.
 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, masonry, stonework, unless otherwise indicated.
 1. Shop prime with primers specified in Section 09 painting Sections unless primers specified in Section 09 Section "High-Performance Coatings" are indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning." requirements indicated below:
 1. Items Indicated to Receive Primers Specified in Section 09 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Other Items: SSPC-SP 3, "Power Tool Cleaning."

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip

galvanized after fabrication and are for bolted or screwed field connections.

- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Art
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete
- B. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
 - 1. Embed anchor bolts at least 4 inches (100 mm) in concrete.
- C. Anchor bollards in concrete [with pipe sleeves preset and anchored into concrete] [in formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch

toward bollard.

- D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- E. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Division 07 92 00 "Joint Sealants" to provide a watertight installation.

3.5 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.

3.6 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

06 10 00

ROUGH CARPENTRY AND PLYWOOD

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
 - 1. Dimension Lumber
 - 2. Wood furring, grounds, nailers and blocking.
 - 3. Plywood wall sheathing at areas indicated.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete.
 - 2. Section 05 50 00 – Metal Fabrications.
 - 3. Section 06 20 00 – Finish Carpentry.
 - 4. Section 07 27 26 – Fluid-Applied Membrane Weather Barriers.
 - 5. Section 07 52 16 – SBS Modified Bitumen Membrane Roofing.
 - 6. Section 07 60 00 – Flashing and Sheet Metal.
 - 7. Section 09 21 16 – Gypsum Board Assemblies for weather resistant gypsum sheathing at all locations other than where plywood wall sheathing is noted.
 - 8. Section 10 28 13 – Toilet Accessories.

1.4 DESIGN/PERFORMANCE REQUIREMENTS

- A. Structural Performance
 - 1. Design Wind Load: Refer to Structural General Notes.
 - 2. Roof Loads: Design, fabricate and install roof framing to resist a uniform roof live load of 20-psf and 20-psf dead load.
 - 3. Deflection Limits: Design truss system to withstand design wind, dead and live loads without deflection greater than the following:
 - a. Roof Framing: Vertical deflection of L/240 of the clear span or 3/4," whichever is less.

1.5 SUBMITTALS

- A. Product Data: Submit product data for engineered wood products, underlayment, insulating sheathing, air infiltration barrier, and construction adhesives. Submit product data for each size of metal framing anchors and hurricane anchors indicating load capacity.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that materials comply with requirements.

1.6 QUALITY ASSURANCE

- A. Wood Structural Design Standard: Comply with applicable requirements in AFPA's "National Design Specifications for Wood Construction" and its "Supplement."

1.7 ENVIRONMENTAL PERFORMANCE REQUIREMENTS:

- A. Provide structural sheathing and underlayment manufactured without a formaldehydebased binding resin or that has a formaldehyde emission below 0.05 ppm.
- B. Do not use woods listed by CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), www.cites.org.
- C. Preservative treatments shall be waterborne, free of arsenic and chromium.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces.
- B. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

PART 2 PRODUCTS

2.1 DIMENSION LUMBER

- A. Provide lumber manufactured to comply with DOC PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review. Provide dressed lumber, S4S, air seasoned with maximum 19 percent maximum moisture content, "SDRY," 2-inch or less in nominal thickness. Provide graded and grade-marked lumber as follows, complying with the association grading rules, under whose rules the material was produced. In the event Contractor wishes to use lumber of other species or grades, submit pertinent data for Architect's approval prior to placing orders.
 - 1. Blocking, Furring, Rough Lumber, Joists, Rafters, Headers Beams and Other Horizontal Framing, Not Otherwise Specified: Douglas Fir - Larch No. 2 (WWPA) or Southern Pine No. 2 (SPIB). Preservative treat all plates and other lumber in contact with concrete and roof fascia's.
 - 2. Preservative treat as specified roof curbs and cants; all nailers, blocking, and plates in contact with concrete or masonry; roof edges; wood framing members less than 18" above grade, structural support for decks; and other items indicated.

2.2 CONSTRUCTION PANELS

- A. Provide plywood panels complying with DOC PS1 "US Product Standard for Construction and Industrial Plywood" and mat formed or composite panels complying with DOC PS2 "Performance Standards for Wood-based Structural-Use Panels." Factory-mark each panel with APA trademark indicating compliance with grade requirements. Provide the following:
 - 1. Plywood Wall Sheathing: APA RATED SHEATHING, EXTERIOR or EXPOSURE 1, 32/16, minimum 1/2" thick, veneer plywood only.
 - a. Corrosion-Resistant Insulation Fasteners and Plates for Use with Steel Roof Decks: Provide Johns-Manville, Inc. "UltraFast" hex washer head fasteners with a modified buttress thread form, "X" point tip and blue "ClimaSeal Premium Coating" exceeding the corrosion resistance of FM #4470 for Class 1A Insulated Steel Deck Construction, including I-90 Windstorm Resistance, or equivalent recommended by roof manufacturer in writing. Provide No. 12 fasteners size x length required to penetrate deck by at least 3/4-inch.

2. Exposed Plywood for Equipment Mounting: Exterior type, APA A-C, EXTERIOR, thickness indicated.

2.3 PRESERVATIVE TREATMENT

- A. Comply with applicable requirements of AWPA C2 (Lumber) and AWPA C9 (plywood). Provide treatment after members are shaped with waterborne micronized copper quaternary (MCQ), ammonical copper quat-B (ACQ-B), alkaline copper quat-D (ACQD), or copper azole (CA-B) preservative by vacuum pressure full-cell process in accordance with AWPA Standard Specification P-5 and as follows:
 1. Above Ground Use Waterborne Dry Salt Retention: 0.25 lb./cu. ft.
 2. Kiln dry members after treatment to 15% MC. Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
 3. Re-grade and re-stamp lumber after kiln drying in accordance with lumber producer's grading rules.

2.4 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 1. Use treatment that does not promote corrosion of metal fasteners.
 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat items indicated on Drawings, and the following:
 1. Framing for raised platforms.
 2. Framing for stages.
 3. Concealed blocking.
 4. Plywood backing panels.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Set rough carpentry work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
 1. Securely attach carpentry work to substrate by anchoring and fastening as shown and as required by the Nailing Schedule requirements of local codes of authorities having jurisdiction.
 2. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not penetrate members where opposite side will be exposed or covered with finish

- materials. Make tight connections between members. Install fasteners without splitting of wood; pre-drilled wood members as required.
3. Do not use materials with defects that might impair quality of rough carpentry or pieces that are too small to use with minimum joints or optimum joint arrangement.
 4. Except as otherwise specified, use hot-dip galvanized nails for all exterior work.
- B. Plywood: Follow applicable recommendations contained in Form No. E30L, "APA Design/Construction Guide-Residential & Commercial," for plywood product types and applications shown.
1. Wall Sheathing: Provide 1/8" space between long edges of panels and 1/8" space between panel ends. Nail 6" o.c. maximum along panel edges and 12" o.c. maximum along intermediate supports with 10d common nails. For panels subject to high wind loads, nail 4" o.c. along all panel edges and 6" o.c. along intermediate framing with 10d common nails or 8d ring shank nails. Extend sheathing to the lowest point of plate.
 2. Roof Sheathing/Insulation: Provide 1/8" space between long edges of panels and 1/8" space between panel ends. Screw fasten 6" o.c. maximum along panel edges and 12" o.c. maximum along intermediate supports with self-drilling corrosion-resistant sheet metal screws to metal roof deck to comply with roof deck performance requirements. For panels subject to high wind loads, screw fasten 4" o.c. along all panel edges and 6" o.c. along intermediate framing with with corrosion-resistant self-drilling sheet metal screws through load dissipating washers. Install two layers of nail base roof insulation with long dimension perpendicular to roof deck and with all joints staggered at least 24-inches from layer below.
 3. Use full sheets of sheathing to the greatest extent possible; do not use scraps to fill in areas.
 4. Extend wall sheathing to the lowest point of wood framing top and bottom.
 5. Provide 1/8" space between long edges of panels and 1/8" space between panel ends. Locate wall sheathing panel long dimension edges over support framing members. Stagger wall and roof sheathing panel end joints from course to course at least 16."
- C. Cover sheathing with fluid-applied membrane weather barrier, shingle lapped, and nailed with galvanized roofing nails. Tape all joints and laps with sheathing tape. Repair deteriorated or damaged fluid-applied membrane weather barrier conforming to specified requirements.

END OF SECTION

06 20 00

FINISH CARPENTRY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior standing and running trim.
 - 2. Interior fixed and adjustable closet and storage shelving.
- B. Related Requirements:
 - 1. Section 06 10 00 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view].
 - 2. Section 06 40 00 "Architectural Woodwork" for shop fabricated wood cabinets and wood paneling.
 - 3. Section 07 92 00 "Joint Sealants."
 - 4. Section 09 90 00 "Painting and Coating."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
- B. Samples for Initial Selection: For each type of product involving selection of colors, profiles, wood species, and cut, and.
- C. Interior Standing and Running Trim Samples: 2'-0" long x full board or molding width, unfinished.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry only when environmental conditions meet requirements specified for installation areas. If finish carpentry must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

PART 2 PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by the

American Lumber Standards' Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
 2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
- B. Softwood Plywood: DOC PS 1.
- C. Hardboard: AHA A135.4
- D. Glue: Provide aliphatic or phenolic-resin wood glue recommended for general carpentry use.

2.2 FINISH CARPENTRY

- A. WM/Series Wood Molding Patterns: For stock molding patterns graded under Wood Molding and Millwork Producers Industry Standard WM 4, provide P-Grade for painted finish and N-Grade for transparent finish, fabricated from any Western softwood species graded and inspected by WWPA.
1. Wood Base (Basis of Design): BMC Wedge Baseboard BW2-FJ, 7/16-inch x 3-1/4-inch finger-jointed paint grade pine.
- B. Standing and Running Trim for Painted Finish: Any Western softwood species graded and inspected by WWPA complying with following requirements:
1. Grade for Standard Sizes and Patterns: "C Select" or "Choice" for Idaho White Pine.
 2. Grade for Special (Custom) Sizes and Patterns: AWI "Custom Grade" for quality of materials and manufacture.

2.3 MISCELLANEOUS MATERIALS

- A. Adhesives: Provide type of adhesives recommended by AWI to suit specified application.
- B. Fasteners: Provide nails, screws, and other anchoring devices of type, size, material and finish required for application indicated to provide secure attachment, concealed where possible and complying with applicable Federal Specifications. Provide hot-dip galvanized finish (ASTM A 153) on all fasteners exposed to exterior and high relative humidity.
- C. Joint Sealants: Refer to Section 07 90 00 for requirements.

2.4 FABRICATION

- A. Back out or kerf backs of standing and running trim wider than 5 inches, except members with ends exposed in finished work.
- B. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed. Cut to required lengths and prime ends. Comply with requirements in Section 09 Section "Painting and Coating."

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.
- B. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 3. Coordinate finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate finish carpentry.

3.4 ADJUSTING

- A. Replace finish carpentry that is damaged or does not comply with requirements. Adjust joinery for uniform appearance.

3.5 CLEANING

- A. Clean finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.6 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

06 40 00

ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing the following:
 - 1. Plastic laminate clad wood cabinets and cabinet tops.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 06 10 00 – Rough Carpentry.
 - 2. Section 06 20 00 – Finish Carpentry.
 - 3. Section 09 65 00 – Resilient Flooring.
 - 4. Section 09 90 00 – Painting and Coating.
 - 5. Division 22 Sections – Plumbing equipment and systems.
 - 6. Division 26 Sections – Electrical equipment and systems.
 - 7. Division 27 Sections – Communication equipment and systems.

1.4 REFERENCES

- A. Referenced Standards: AWI "Architectural Woodwork Quality Standards", 7th Edition, Ver. 1.2, 1999, except comply with more stringent requirements specified.

1.5 SUBMITTALS

- A. Submit shop drawings showing location of each item, elevations, and large scale details, indicating related work and complete method of connections, jointing, support, anchorage, reinforcement, material types (including wood species, cut, high pressure decorative laminate grade, finish and color), hardware, and finishes. Show and note field dimensions requiring field measurement for verification and coordination with related work. Submit samples of plastic laminate, each type of hardware, and opaque finished wood.
- B. Environmental Submittals:
 - 1. Certification of compliance with the environmental performance requirements specified.
 - 2. Material Safety Data Sheets (MSDS) for adhesive and coatings.
 - 3. Energy performance data.
 - 4. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Fabricator/Installer Qualifications: Arrange for work of this Section to be performed by a firm with not less than 3 years successful experience in fabrication and finishing of woodwork similar to required work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and will maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.
 - 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.9 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Wood Materials, General: Quality grade, wood specie, cut and match required are specified for each category of architectural woodwork item. Unless otherwise specified, provide lumber and panel products of the grades required by the referenced "Quality Standard" for each quality grade for each woodwork item specified. Where optional materials are indicated within each "Quality Standard" grade, choice is left to fabricator, unless otherwise specified. Particle Board is not acceptable for use on this project and therefore is not indicated below.
 - 1. Provide materials that comply with requirements of AWI referenced "Quality Standard" for each type of woodwork and quality grade indicated and, where the following products are part of woodwork, with requirements of the referenced product standards, that apply to product characteristics indicated.
 - a. Hardboard: AHA A135.4.
 - b. High Pressure Decorative Laminate: NEMA LD 3.
 - c. Medium Density Fiberboard: ANSI A20
 - d. Softwood Plywood: DOC PS-1
 - e. Hardwood Plywood and Face Veneers: HPVA HP-1.
 - f. Formaldehyde Emissions: Comply with the following:

- 1) Medium Density Fiberboard: NPA-9.
 - 2) Hardwood Plywood: HPMA FE.
- B. High Pressure Decorative Laminate: NEMA LD3 for each exposure and grade required, color as selected; Refer to Finish Legend, elevations and details on the Drawings for product selections, colors, and locations required.
- C. Cabinet Hardware and Miscellaneous Item Schedule: All hardware shall meet ANSI A156.9. Refer to Finish Legend on the Drawings for cabinet hinges, pulls, drawer slides and Drawing cabinet elevations for locations required.
1. Catches: Provide opening resistance in compliance with the ADA. Provide top mounted magnetic catch for base and wall cabinet door. Provide two at each tall cabinet door.
 2. Adjustable Shelf Supports: Provide dual-pin design with anti-tip-up shelf restraints for both 3/4 inch and 1 inch shelves. Include keel to retard shelf slid-off, and slot for mechanical attachment for shelf to clip. Load rating shall be minimum 300 pounds each support without failure.
 3. Wardrobe Rod: Provide 1-1/6-inch diameter plated steel rod, with captive sockets.
 4. Coat Hooks: Single or double prong, wall mounted in satin aluminum.
 5. Cabinet Locks: Five-disk tumbler cam-style with strike. Locks on cabinets in same room keyed alike unless indicated otherwise in the drawings. Provide two keys per room where doors and drawers are scheduled to receive locks. Provide US26D dull chrome finish. Lock core shall be removable with a control key, permitting Owner to change lock arrangements without tools.
 6. Grommets: Provide 2-1/2 inches in diameter with "Flip-Top"™ tab in cap, located where electrical, telephone, and computer data wiring need to pass through tops whether shown or not.
 7. Keyboard Drawers: Located at all knee spaces.
 8. Pulls: Unless indicated otherwise in drawings, provide 5" wire pulls, with brushed nickel finish.
- D. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q, 6 mm thick, unless otherwise indicated.
- E. Architectural Cabinets, Laminate Clad: Comply with AWI Section 400 and Division 400B, and AWI "Architectural Casework - General".
1. Laminate Clad Cabinets: "Custom Grade"; flush overlay construction, with any close-grained hardwood listed in the referenced "Quality Standard" for the quality grade specified.
 2. Panel product for semi-exposed panel product parts with high pressure decorative laminate shall be same as for exposed surfaces. Provide 1 mm PVC edge banding, matching panel face, at all edges exposed to view.
 3. Panel product for exposed panel product parts with high pressure decorative laminate shall be medium density fiberboard plywood, softwood veneer core plywood, or lumbercore plywood listed in the referenced "Quality Standard" for the quality grade specified, except shelves spanning more than 12" shall be veneer or lumber core plywood only.
 4. Laminate for Exposed Surfaces and Edges: GP-50 grade.
 5. Laminate for Semi-Exposed Surfaces: GP-28 grade.
- F. Architectural Cabinet Tops and Cabinet Trim: Comply with AWI Section 400 and Division 400C, and AWI "Architectural Casework - General". Provide the following:
1. Laminate Clad Tops (Laminate Clad Casework Only): "Custom Grade"; with GP- 50 grade laminate at exposed surfaces and edges, BK-50 grade backer sheet at underside of panel core, Interior Type 1M1 medium density fiberboard panel cores,

except at tops where sinks occur, use APA EXT A-C veneer plywood or Exterior Type 2M2 phenolic resin fiberboard. Laminate core to rails, except provide glued-under-pressure lumber drop edge with dado and rabbet continuous lock joint wherever unsupported area of top exceeds 4 sq. ft. Use maximum length laminate with a minimum number of joints. Install laminate on edge first and then on surface. Uniformly bevel edges 15 degrees from edge surface.

2. Solid Surfacing Countertops: See the Finish Legend on the Drawings for product selection, color and thickness required. Provide sub top solid lumber ladder frames to support countertops.

2.2 FABRICATION

- A. Comply with AWI "Quality Standards" for lumber moisture content at time of fabrication and for relative humidity conditions in the installation areas.
- B. Complete fabrication, assembly, finish hardware application, and other work before shipment to the Project Site to maximum extent possible. Allow for scribing and fitting. Pre-cut openings for related work.
- C. Take field measurements for work required to be fitted to other construction.
- D. Edge band shelf edges, cabinet door edges and exposed cabinet edges with 3/8-inch hardwood, except where greater depth is required to secure hardware. Use full length pieces only.
- E. Apply plastic laminate finish in full uninterrupted sheets consistent with maximum manufactured sizes. Make corners and joints hairline. Locate counter butt joint minimum 2 feet from sink cut-outs. Apply plastic laminate face sheets after application of plastic laminate to edges. Bevel edges 15d from edge surface.
- F. Cap exposed plastic laminate edges with material of same finish and pattern.
- G. Mechanically fasten splash backs to countertops with steel brackets at 16" o.c. unless shown or noted otherwise.
- H. Apply laminate backing sheet to concealed side of plastic laminate finished surfaces.

PART 3 EXECUTION

3.1 PREPARATION

- A. Condition woodwork to average prevailing humidity conditions in installation areas prior to installing.
- B. Pre-Installation Meeting: Meet at the Project Site prior to delivery of architectural woodwork and review coordination and environmental controls required for proper installation and ambient conditioning in areas to receive work. Include in meeting the Contractor, Architect and City of Houston Representatives (if any), Installers of architectural woodwork, wet work including plastering, other finishes, painting, mechanical work and electrical work, and firms and persons responsible for continued operation (whether temporary or permanent) of HVAC system as required to maintain temperature and humidity conditions. Proceed with woodwork installation only when everyone concerned agrees that required ambient conditions can be maintained.

3.2 EXECUTION

- A. Install the work rigid, plumb, level and true with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level, and with no variations in flushness of adjoining surfaces.
- B. Scribe and cut work to fit adjoining work leaving gap of 1/32 inch to adjacent surfaces. Repair or replace damaged finish at cuts. Do not use additional overlay trim for this purpose.
- C. Where field cutting or trimming is necessary, perform Work in a neat, accurate, professional manner without damaging woodwork and adjacent Work.
- D. Anchor woodwork to anchors or blocking built-in or directly attached to substrates.
- E. Counter-sink screw anchorage devices at exposed locations used to wall mount components. Conceal screw fasteners with solid plugs of species to match surrounding wood, grain and color. Finish flush with surrounding surfaces.
- F. Cabinets: Install with concealed fasteners, without distortion, so that doors and drawers will fit openings properly, and be accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated. Maintain veneer sequence matching (if any) of cabinets with transparent finish.
- G. Tops, General: Anchor securely to base units with concealed fasteners and other support systems as indicated. Join countertop cores with a minimum of 4 wood biscuits arranged to provide flush, tight joints.
- H. Repair damaged and defective woodwork and finishes; where possible eliminate functional and visual defects; where repair is not possible, replace item.
- I. Refer to Section 09 90 00 for field finishing of exposed opaque finished woodwork.

END OF SECTION

06 80 00

FIBERGLASS REINFORCED PANELING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing fiberglass reinforced plastic paneling.
- B. Related Work of Other Sections:
 - 1. Division 03 Section – Cast-In-Place Concrete.
 - 2. Division 04 Section – Unit Masonry.
 - 3. Division 05 Section – Cold-Formed Metal Framing.
 - 4. Division 05 Section – Metal Fabrications.
 - 5. Division 07 Section – Joint Sealants.
 - 6. Division 07 Section – Sound Batt Insulation
 - 7. Division 08 Section – Hollow Metal Doors and Frames.
 - 8. Division 08 Section – Entrances and Storefront.
 - 9. Division 09 Section – Painting and Coating.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature for each type of Fiberglass Reinforced Panel and accessory required.
- B. Shop Drawings: Submit seaming diagrams for the entire work
- C. Samples: Submit samples in manufacturer's standard size of each different type of Fiberglass Reinforced Panel and each different type of accessory as requested by Architect.
- D. Product Schedule: Use same designations indicated on Drawings.
- E. Maintenance Data: For Fiberglass Reinforced Panels to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining panel system, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to the fiberglass reinforced panel system.

1.4 QUALITY ASSURANCE

- A. Field Measurements: Measure each space to receive fiberglass reinforced paneling, as a basis for supplying, cutting, and seaming the paneling. Do not scale the Architect's drawings or calculate sizes from indicated dimensions.

1.5 SEQUENCING AND SCHEDULING

- A. Sequence and schedule installation of Fiberglass Reinforced Paneling with other work to minimize the possibility of damage of Paneling during the remainder of the construction period.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Follow Manufacturer's recommendations for the delivery, storage, and handling of the Fiberglass Reinforced Paneling system(s) used on the project.
- B. Fiberglass Reinforced Paneling shall remain in original manufacturer's packaging until such time as it is to be installed.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

2.2 FIBERGLASS REINFORCED PANELING

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D 5319.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Crane Composites, Inc.
 - b. Glasteel.
 - c. Marlite.
 - d. Newcourt, Inc.
 - e. Nudo Products, Inc.
 - f. Parkland Plastics, Inc.
 - 2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E 84. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 3. Nominal Thickness: Not less than 0.075 inch.
 - 4. Surface Finish: As chosen by architect from manufacturer's standard range.
 - a. Refer to drawings for finish.
 - 5. Color: As chosen by architect from manufacturer's standard range.
 - a. Refer to drawings for color.

2.3 ACCESSORIES

- A. Adhesive: As recommended by plastic paneling manufacturer.
- B. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Joint Sealants."

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.
- B. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- C. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels unless otherwise indicated.
 - 1. Mark plumb lines on substrate at panel joint locations for accurate installation.
 - 2. Locate panel joints to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- D. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION

07 11 00

DAMPPROOFING AND WATERPROOFING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing the following.
 - 1. Bentonite waterproofing at exterior of elevator pit walls and floors, and at below-grade areas indicated by geotechnical report to have standing water or higher-than-usual static water pressures.
 - 2. Molded-sheet drainage panels.
 - 3. Cold-Applied asphalt emulsion dampproofing compound for exterior face of other below grade walls.
- B. Related Sections include the following:
 - 1. Section 03 30 00 "Cast-In-Place Concrete."
 - 2. Section 31 23 00 "Earth Moving" for excavating and backfilling.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include product specifications and manufacturer's written installation instructions.
- B. Shop Drawings: Show installation details for interface with other work.
- C. Samples: For each of the following products, in sizes indicated:
 - 1. Waterproofing: 6 inches square.
 - 2. Drainage Panels: 6 inches square.
 - 3. Damp Proofin: 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type of bentonite waterproofing, and each type of asphalt emulsion dampproofing, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for bentonite waterproofing and asphalt emulsion dampproofing.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty for each type of product indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain bentonite waterproofing system from single source from single

manufacturer. Obtain accessory products used with bentonite waterproofing from sources acceptable to bentonite waterproofing manufacturer.

- B. Mockups: Build mockups to verify selections made under sample submittals and to set quality standards for fabrication and installation.
 - 1. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original unopened and undamaged containers.
- B. Store materials in a dry, well-ventilated space.
- C. Remove and replace bentonite materials that have been prematurely exposed to moisture.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit approved dampproofing and waterproofing materials to be installed according to manufacturers' written instructions and warranty requirements.
 - 1. Do not apply dampproofing or waterproofing materials to surfaces where ice or frost is visible. Do not apply dampproofing or waterproofing materials in areas with standing water.
 - 2. Placing bentonite clay products in panel or composite form on damp surfaces is allowed if approved in writing by manufacturer.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree(s) to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GEOTEXTILE/BENTONITE SHEETS

- A. Bentonite Panels: 3/16-inch- thick, corrugated kraft-paper panels with a minimum of 1.0 lb/sq. ft. of bentonite confined in corrugations of boards.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carlisle Coatings & Waterproofing; CCW MiraCLAY.
 - b. CETCO; Voltex.
 - c. Volclay

2.2 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding

No. 70 sieve laminated to one side of the core, with a polymeric film bonded to the other side; and with a vertical flow rate of 9 to 18 gpm per ft.

2.3 COLD-APPLIED ASPHALT EMULSION DAMPPROOFING

- A. Asphalt-based, clay emulsion with non-asbestos fibers.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Henry 789 Fibered Asphalt Emulsion Dampproofing
 - b. Chem Masters Masterguard 400
 - c. W.R. Meadows Sealmastic Type II Emulsion
 - d. Karnak 220 Fibered Emulsion Dampproofing

2.4 ACCESSORIES

- A. General: Manufacturer's standard accessories recommended for intended use and compatible with specified Dampproofing and Waterproofing.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of specified dampproofing and waterproofing.
- B. Verify that substrate is complete and that work that will penetrate dampproofing and waterproofing is complete and rigidly installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate work in the vicinity of dampproofing and waterproofing to ensure proper conditions for installing the dampproofing and waterproofing systems and to prevent damage to dampproofing and waterproofing after installation.
- B. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with cement grout patching material according to manufacturer's written instructions.
 - 1. Where requirements for dampproofing material and waterproofing material are in conflict, the more stringent requirements shall be used for the extent of the formed concrete surfaces.
- C. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of dampproofing and waterproofing. Fill voids, cracks greater than 1/8 inch, honeycomb areas, and other defects with cement grout patching material according to manufacturer's written instructions.
 - 1. Where requirements for dampproofing material and waterproofing material are in conflict, the more stringent requirements shall be used for the extent of the horizontal concrete surfaces.

3.3 INSTALLATION, GENERAL

- A. Install dampproofing, waterproofing, and accessories according to manufacturer's written

instructions.

- B. Protect dampproofing and waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts according to manufacturer's written instructions.
- C. Install protection course before backfilling or placing overburden when recommended by dampproofing and/or waterproofing manufacturer
 - 1. Where requirements for dampproofing and waterproofing are in conflict, the more stringent requirements shall be used for the extent of the Work.

3.4 BENTONITE WATERPROOFING INSTALLATION

- A. Apply granular bentonite around penetrations in horizontal surfaces and changes in plane according to manufacturer's details in preparation for granular bentonite tubes and mastic.
- B. Apply granular bentonite tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
- C. Apply granular bentonite tubes continuously on footing against base of wall to be waterproofed according to manufacturer's written instructions.

3.5 GEOTEXTILE/BENTONITE SHEET INSTALLATION

- A. General: Install a continuous layer of waterproofing sheets directly against concrete to be waterproofed. Lap ends and edges a minimum of 4 inches on horizontal and vertical substrates. Stagger end joints between sheets a minimum of 24 inches. Fasten seams by stapling to adjacent sheet or nailing to substrate.
- B. Below Structural Slabs-on-Grade: Place waterproofing sheets on compacted substrate with ends and edges lapped and stapled.
 - 1. Install a layer of waterproofing sheets under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches up or beyond perimeter slab forms.
- C. Concrete Walls: Starting at bottom of wall, apply waterproofing sheets horizontally with primary backing side against wall. Secure with masonry fasteners spaced according to manufacturer's written instructions. Extend to bottom of footing, grade beam, or wall, and secure.
 - 1. Termination at Grade: Extend waterproofing sheets to within 2 inches of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.

3.6 COLD APPLIED ASPHALT EMULSION DAMPPROOFING INSTALLTION

- A. Apply in two-coats, allowing first coat to become tacky or dry to touch prior to applying second coat.
 - 1. Dilute first coat by 20% to 25% with cool, clean water. Apply second coat undiluted.
- B. Ensure that coating is free of breaks or pinholes.
- C. Ensure that coating continues over top edges of footings, and into all joints, grooves, slots, chases, corners, and reveals.
- D. Backfill shall be placed against finished walls no sooner than 48 hours, and no later than 7 days after application.

1. Ensure that backfill placement does not damage, rupture, or tear the film, or cause the coating or membrane to be displaced or dislocated on the wall.

3.7 FIELD QUALITY CONTROL

- A. Inspection: Arrange for manufacturer's representatives to inspect completed dampproofing and waterproofing installation before covering with other construction (including backfilling,) and provide written report that installation complies with manufacturer's written instructions.
 1. Remove and replace applications of dampproofing and waterproofing where inspection indicates that it does not comply with specified requirements.

END OF SECTION

07 21 00

THERMAL INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing the following.
1. Glass-fiber blanket insulation within perimeter cold-formed metal framing, soffits and other areas indicated.
 2. Foam Board continuous cavity insulation over air barrier at exterior sheathing locations with noncombustible exterior finishes.
 3. Rigid cavity non-combustible continuous insulation over air barrier at all other exterior sheathing and other areas indicated.
 4. Interior fire rated partition insulation and fire safing.
- B. Related Work of Other Sections:
1. Section 04 20 00 "Unit Masonry."
 2. Section 05 40 00 "Cold-Formed Metal Framing."
 3. Section 07 27 26 "Fluid-Applied Membrane Air Barrier."
 4. Section 07 42 13 "Metal Wall Panels."
 5. Section 07 52 16 "SBS Modified Bitumen Membrane Roofing."
 6. Section 07 62 00 "Sheet Metal Flashing and Trim."
 7. Section 07 92 00 "Joint Sealants."
 8. Section 08 41 00 "Entrances and Storefronts."
 9. Section 09 21 16 "Gypsum Board Assemblies."
 10. Section 09 24 00 "Plaster Assemblies."
 11. Section 09 51 00 "Acoustical Ceiling Assemblies."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corporation.
 - 2. Guardian Building Products, Inc.
 - 3. Johns Manville.
 - 4. Knauf Insulation.
 - 5. Owens Corning.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Blanket Insulation: Unfaced 3-1/2-inch R-11 and 8-inch thick R-25, Greenguard certified fiberglass or mineral wool blanket insulation; CertainTeed CertaPro™ Acousta- Therm™ Batts-Unfaced, Knauf Unfaced Rolls, or Owens-Corning Unfaced Thermal Batt Insulation
 - 1. Tapes and Sealants: 3M No. 8086 Contractor Sheathing Tape.
 - 2. Stucco Netting: For support of blanket insulation as indicated.
 - 3. Wire: Hot-dip galvanized steel wire for support of blanket insulation as indicated.

2.2 FOAM BOARD CONTINUOUS INSULATION

- A. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578 with either natural skin or cut cell surfaces.
 - 1. Type and Compressive Resistance: Type IV, 25 psi (173 kPa), minimum.
 - 2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
 - 4. Type and Thermal Resistance, R-value (RSI-value): Type IV, 5.0 (0.88) per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature.
 - 5. Complies with fire resistance requirements shown on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
 - 6. Board Edges: Square.
 - 7. Type and Water Absorption: Type IV, 0.3 percent by volume, maximum, by total immersion.
 - 8. Manufacturers:
 - a. Dow Chemical Company; STYROFOAM HIGHLOAD 40: www.dow.com/#sle.
 - b. Kingspan Insulation LLC; GreenGuard XPS TYPE IV 25 PSI: www.trustgreenguard.com/#sle.

- c. Kingspan Insulation LLC; GreenGuard XPS TYPE VI 40 PSI:
www.trustgreenguard.com/#sle.
- d. Owens Corning Corporation; FOAMULAR Extruded Polystyrene (XPS)
Insulation: www.ocbuildingspec.com/#sle.
- e. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 NON-COMBUSTIBLE CONTINUOUS CAVITY INSULATION

- A. Partition and Safing Insulation: ASTM C 612, Class 1A, 1B, and 1VA.
 - 1. Spun mineral wool semi-rigid non-combustible felts, Owens Corning "Thermafiber RainBarrier 45" Fire Safing Insulation or equivalent accepted by Architect.
 - 2. Fire Hazard Classification (ASTM E 84): Non-combustible as defined by NFPA Standard 220
 - a. Flame Spread: 0.
 - b. Smoke Developed: 0.
 - 3. Moisture Absorbance (ASTM C 1104): 0.03 percent by volume.
- B. Size: Nominal 1-1/2" thickness by 24" width for continuous cavity insulation.
- C. Accessories: Provide minimum 0.0538" thick galvanized steel "Impasse Z-Furring Hanger" installation over cold-formed metal framing or manufactures 1-1/2-inch head diameter hot-dip galvanized CMU anchors spaced 16" on center both ways. as recommended by insulation manufacturer to permanently secure insulation in place. Coordinate insulation installation with masonry wall tie installation.

2.4 PARTITION SAFING INSULATION

- A. Partition and Safing Insulation: ASTM C 612, Class 1 and 2.
 - 1. Spun mineral wool semi-rigid non-combustible felts, United States Gypsum Company "Thermafiber" Fire Safing Insulation or equivalent accepted by Architect.
 - 2. Fire Hazard Classification (ASTM E 84):
 - a. Flame Spread: 15.
 - b. Fuel Contributed: 0.
 - c. Smoke Developed: 0.
- B. Size: Nominal 2" thickness for partition insulation and 4" thickness by depth required for a two-hour fire stop and other penetration conditions indicated.
- C. Accessories: Provide minimum 0.0538" thick galvanized steel floor closure plate and minimum 0.016" thick galvanized steel or minimum 0.013" thick stainless steel sheet metal impaling clips as recommended by insulation manufacturer to permanently secure insulation in place.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to

ice, rain, or snow at any time.

- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.
- E. Install insulation below existing roof deck on suspension wires installed as high as possible.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

- A. On vertical surfaces, set insulation units tightly laid according to manufacturer's written installation instructions over air barrier and gypsum sheathing: Install CMU drilled in anchors spaced 16 inches o.c. both ways on outside face, and as recommended by insulation manufacturer. Fit courses of insulation horizontally between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

3.4 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

07 27 26

FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Continuous fluid-applied, vapor-retarding membrane air-water barrier at all exterior above grade surfaces of backup construction for masonry, stone, metal panels, and similar cladding and veneer finish systems.
 - 2. Air-water barrier transition flashing to adjacent related work to comply performance requirements.
- B. Related Sections include the following:
 - 1. Section 03 30 00 "Cast-In-Place Concrete."
 - 2. Section 04 20 00 "Unit Masonry."
 - 3. Section 06 10 00 "Rough Carpentry" for plywood sheathing substrates
 - 4. Section 07 41 13 "Metal Roof Panels."
 - 5. Section 07 62 00 "Sheet Metal Flashing and Trim."
 - 6. Section 08 41 00 "Entrances and Storefront."

1.3 1.3 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.
- B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and ties-ins with adjoining construction.
2. Include details of interfaces with other materials that form part of air barrier.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by the Installer, who work on Project.
- B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
- C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 1. Build integrated mockups of exterior wall assembly, 150 sq. ft. (14 sq. m), incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
 - b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
 - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
 1. Protect substrates from environmental conditions that affect air-barrier performance.
 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Performance Characteristics:
 - 1. Air Penetration: 0.0002 cfm/ft² at 75 Pa, when tested in accordance with ASTM E 2178. Type I per ASTM E 1677 and ≤ 0.01 cfm/ft² at 75 Pa, when tested in accordance with ASTM E 2357.
 - 2. Water Vapor Transmission: 25 perms, when tested in accordance with ASTM E 96, Method B at 25 mils DFT (Dry Film Thickness).
 - 3. Water Penetration Resistance: Greater than 1000 cm when tested in accordance with AATCC Test Method 127. No leakage at 15 psf when tested in accordance with ASTM E 331.
 - 4. Air Resistance: Air infiltration greater than 10,000 seconds per 100cc, when tested in accordance with TAPPI Test Method T-460
 - 5. Tensile Strength: Minimum 169 lbs/in², when tested in accordance with ASTM D 412.
 - 6. Estimated Elongation: 420% in accordance with ASTM D 412.
 - 7. Hardness: Passes at a Shore A hardness of 71, when tested in accordance with ASTM D 2240.
 - 8. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E 84. Flame Spread: 25, Smoke Developed: 25.
 - 9. Accelerated Weathering: 9 month exposure of membrane to ultraviolet light (UV) in accordance with ASTM G 155.
 - 10. Volatile Organic Content (VOC): Less than 2% when measured in accordance with ASTM C 1250.
 - 11. Adhesion Strength (Concrete): Greater than 33 psi when measured in accordance with ASTM D 4541.

2.3 VAPOR-RETARDING MEMBRANE AIR BARRIER

- A. A single-component, low VOC, 25 mil thick synthetic polymer fluid-applied product with superior elasticity and flexibility providing resistance to air flow, bulk water and wind driven rain yet allows moisture vapor to escape.
- B. Basis of Design: DuPont™ Tyvek® Fluid Applied WB System; including DuPont™ Tyvek® Fluid Applied WB, DuPont™ Tyvek® Fluid Applied Flashing and Joint Compound, DuPont™ Tyvek® Fluid Applied Flashing – Brush Grade and DuPont™ Sealant for Tyvek® Fluid Applied Systems.

2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
 - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
 - 1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of 3 inches (75 mm) along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.
- B. Gypsum and Plywood Wall Sheathing: Fill joints greater than 1/4 inch (6 mm) with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

3.4 TRANSITION STRIP INSTALLATION

- A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install butyl sealant (at single ply roofing) and modified bituminous (at modified bitumen membrane roofing) strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply sheet flashing transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.
 - 1. Adhesive-Coated Flexible Flashing: Roll firmly to enhance adhesion.
 - 2. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches (150 mm) o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- H. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- I. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, counter flashing strip.
- J. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counter flashings or ending in reglets with termination mastic.
- K. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

- A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature

ranges.

1. Apply primer to substrates at required rate and allow it to dry.
 2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
1. Vapor-Retarding Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil dry film thickness, applied in one or more equal coats.
- C. Apply strip and transition strip a minimum of 1 inch (25 mm) onto cured air-barrier material or strip and transition strip over cured air-barrier material overlapping 3 inches onto each surface according to air-barrier manufacturer's written instructions.
- D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 2. Continuous structural support of air-barrier system has been provided.
 3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
 4. Site conditions for application temperature and dryness of substrates have been maintained.
 5. Maximum exposure time of materials to UV deterioration has not been exceeded.
 6. Surfaces have been primed, if applicable.
 7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 8. Termination mastic has been applied on cut edges.
 9. Strips and transition strips have been firmly adhered to substrate.
 10. Compatible materials have been used.
 11. Transitions at changes in direction and structural support at gaps have been provided.
 12. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 13. All penetrations have been sealed.
- C. Tests: As determined by Owner's testing agency from among the following tests:
1. Qualitative Air-Leakage Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, smoke pencil with pressurization or depressurization.
- D. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.7 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to airbarrier manufacturer's written instructions.
 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- C. Remove masking materials after installation.

END OF SECTION

07 31 00

SOUND BATT INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Glass fiber acoustical blanket Insulation for interior partitions.
- B. Related Sections include the following:
 - 1. Section 07 21 00 "Thermal Insulation."
 - 2. Section 09 20 00 "Plaster and Gypsum Board."

1.3 REFERENCES

- A. Materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:
 - 1. American Society for Testing of Materials (ASTM):
 - a. ASTM C423 Test Method for Sound Absorption Coefficient by the Reverberation Room Method.
 - b. ASTM C518 Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter.
 - c. ASTM C665 Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - d. ASTM E36 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
 - e. ASTM E84 Test Method for Surface Burning Characteristics of Building Materials.
 - f. ASTM E119 Test Methods for Fire Tests of Building Construction and Materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.6 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 PRODUCTS

2.1 FIBERGLASS ACOUSTICAL BATTS (SOUND ATTENUATION BATTS, SAB)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corporation.
 - 2. Owens Corning.
 - 3. Knauf Insulation
- B. Unfaced Glass Fiber Acoustical Insulation, complying with ASTM C665, Type I, of varying thicknesses
- C. Tapes and Sealants: 3M Vibration Damping Tape
- D. Wire: Hot-dip galvanized steel wire for support of blanket insulation as indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF SOUND ATTENUATION BATTS INSULATION IN CEILINGS

- A. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket insulation over entire ceiling area in thicknesses indicated. Extend insulation 48 inches up either side of partitions.

3.4 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

07 41 13

METAL ROOF PANELS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
1. Structural roofing system of preformed steel panels.
 2. Thermal roof insulation.
 3. Attachment system.
 4. Finishes.
 5. Accessories

- A. Related Sections include the following:
1. Section 05 12 00 "Structural Steel Framing"
 2. Section 06 10 00 "Rough Carpentry"
 3. Section 07 92 00 "Joint Sealants"

1.3 REFERENCES

- A. Materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:
1. American Society for Testing of Materials (ASTM):
 - a. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2016.
 - b. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.
 - c. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2010 (Reapproved 2015).
 - d. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2017.
 - e. ASTM C1363 - Standard Test Method for Thermal Performance of Building Envelope Assemblies by Means of a Hot Box Apparatus; 2011.
 - f. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
 - g. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005 (Reapproved 2017).
 - h. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference; 1995 (Reapproved 2011).
 - i. ASTM E1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems; 2016.

2. International Accreditation Service (IAS)
 - a. IAS AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems; 2017.
3. Underwriters Laboratories (UL)
 - a. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies; Current Edition, Including All Revisions.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
 1. Show work to be field-fabricated or field-assembled.
 2. Include structural analysis signed and sealed by qualified structural engineer, indicating conformance of roofing system to specified loading conditions.
- C. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches (305 mm) square, representing actual roofing metal, thickness, profile, color, and texture.
 1. Include typical panel joint in sample.
 2. Include typical fastening detail.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Manufacturer Qualification Statement: Provide documentation showing metal roof panel fabricator is accredited under IAS AC472.
- C. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.
- B. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.8 WARRANTY

- A. See Section 01 70 00 "Execution and Closeout Requirements", for additional warranty requirements.

- B. Finish Warranty: Provide manufacturer's special warranty covering failure of factory-applied exterior finish on metal roof panels and agreeing to repair or replace panels that show evidence of finish degradation, including significant fading, chalking, cracking, or peeling within specified warranty period of twenty years from Date of Substantial Completion.
- C. Waterproofing Warranty: Provide manufacturer's warranty for weathertightness of roofing system, including agreement to repair or replace roofing that fails to keep out water within specified warranty period of twenty years from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 METAL ROOF PANELS

- A. Basis of Design: Berridge Double-Lock Zee-Lock Panel, mechanically field-seamed folded double locking leg standing seam roof system.
- B. Other Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ATAS International, Inc
 - 2. MBCI
 - 3. Centria Metl-Span, a Division of NCI Group, Inc

2.2 STRUCTURAL METAL ROOF PANELS

- A. Roofing System: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for conformance to the following minimum standards:
 - 1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
 - a. Dead Loads: Weight of roofing system.
 - b. Live Loads: As required by ASCE 7 and applicable codes.
 - 2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
 - 3. Wind Uplift: Class 90 wind uplift resistance of UL 580.
 - 4. Air Infiltration: Maximum 0.06 cfm/sq ft (1.1 cubic meters/hr/sq m) at air pressure differential of 6.24 lbf/sq ft (300 Pa), when tested according to ASTM E1680.
 - 5. Water Penetration: No water penetration when tested according to procedures and recommended test pressures of ASTM E1646. Perform test immediately following air infiltration test.
 - 6. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F (56 degrees C).
 - 7. Thermal Performance: Provide thermal resistance through entire system, R-value (RSI-value) of 15 deg F hr sq ft/BTU; 2 inch thick (2.6 K sq m /W; 50.8 mm thick), when tested in accordance with ASTM C1363.
- B. Metal Panels: Factory-formed panels with factory-applied finish.
 - 1. Type: Single skin, uninsulated.
 - 2. Steel Panels:
 - a. Aluminum-zinc alloy-coated SS (structural steel) sheet conforming to ASTM A792/A792M; minimum AZ50 (AZM150) coating.
 - b. Steel Thickness: Minimum 22 gage (0.03 inch) (0.76 mm).
 - 3. Profile: Standing seam, with minimum 2 inch (51 mm) seam height; concealed fastener system for integral standing seam-shaped lap seamfor integral standing seam-shaped lap seam.

4. Texture: Stucco embossed, with intermediate ribs for added stiffness.
5. Length: Full length of roof slope, without lapped horizontal joints.
6. Width: Maximum panel coverage of 24 inches (609.6 mm).
7. Color: As chosen by architect from manufacturer's standard range.

2.3 ATTACHMENT SYSTEM

- A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.4 SECONDARY FRAMING

- A. Miscellaneous Secondary Framing: Light gage steel framing incidental to structural supports; fabricated from steel sheet.
- B. Framing Material: ASTM A 1011/A 1011M, Designation SS steel sheet.
 1. Profile: Manufacturer's standard cee, zee, asymmetrical zee, hat channel, plain channel, single slope eave strut, double slope eave strut, and angle.
 2. Thickness: 12 gage, 0.1046 inch (2.657 mm).
 3. Finish: Galvanized per ASTM A653/A653M, G90.
- C. Framing Connectors: Factory-made formed steel sheet, ASTM A653/A653M SS Grade 50, with G60/Z180 hot dipped galvanized coating and factory punched holes.

2.5 FABRICATION

- A. Panels: Provide factory or field fabricated panels with coil-coated finish and accessory items, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.
- B. Joints: Provide captive gaskets, sealants, or separator strips at panel joints to ensure weathertight seals, eliminate metal-to-metal contact, and minimize noise from panel movements.

2.6 FINISHES

- A. Fluoropolymer Coating System (Exterior): Manufacturer's standard multi-coat thermocured coating system, including minimum 70 percent fluoropolymer color topcoat with minimum total dry film thickness of 0.9 mil (0.023 mm); color and gloss as selected from manufacturer's standards.
- B. Siliconized Polyester Coating (Interior): Epoxy primer and silicone-modified polyester enamel topcoat with minimum dry film thickness (DFT) of 0.8 mil (0.02 mm); color and gloss as indicated on drawings.
- C. Solar Reflectance Index (SRI): 78 minimum, qualifying as a "Cool Roof" for LEED Heat Island Effect Credit.

2.7 ACCESSORIES

- A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
 1. Downspouts: Open face, rectangular profile.

- B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.
- C. Sealants:
 - 1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
 - 2. Concealed Sealant: Non-curing butyl sealant or tape sealant.
 - 3. Seam Sealant: Factory-applied, non-skinning, non-drying type.
- D. Thermal Insulation: Provide flexible blanket, rigid, or semi-rigid type, faced with white, flexible, non-dusting vapor retarder tested for maximum flame spread index of 50, per ASTM E84; for installation using spacer blocks.
 - 1. Thickness: As indicated, or if not indicated, minimum R-value of 9.4 (RSI of 1.7).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed roof will be free of leaks.
- B. Remove protective film from surface of roof panels immediately prior to installation. Strip film carefully, to avoid damage to prefinished surfaces.
- C. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by roof panel manufacturer.
- D. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.3 INSTALLATION

- A. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer's instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.
 - 1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
 - 2. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.
- B. Accessories: Install all components required for a complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.
- C. Roof Panels: Install panels in strict accordance with manufacturer's instructions, minimizing transverse joints except at junction with penetrations.

1. Form weathertight standing seams incorporating concealed clips, using an automatic mechanical seaming device approved by the panel manufacturer.
 2. Provide sealant tape or other approved joint sealer at lapped panel joints.
 3. Install sealant or sealant tape, as recommended by panel manufacturer, at end laps and side joints.
- D. Insulation: Install insulation between roof covering and supporting members to present a neat appearance. Fold, staple, and tape seams unless otherwise approved by Architect.
1. Install rigid or semi-rigid insulation in areas exposed to view.
 2. Install batt insulation in locations that will be concealed from view.
- 3.4 CLEANING
- A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.
- 3.5 PROTECTION
- A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.
- B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION

07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Formed Products:
 - a. Formed sheet metal roof edge flashings.
 - b. Formed sheet metal leader boxes.
 - c. Formed sheet metal downspouts and downspout straps
 - d. Formed low-slope roof sheet metal fabrications.
 - e. Formed wall sheet metal fabrications.
- B. Related Sections:
1. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking.
 2. Section 07 54 23 "Thermoplastic Polyolefin Roofing" for installing sheet metal flashing and trim integral with membrane roofing.
 3. Section 07 71 00 "Roof Specialties" for manufactured roof specialties not part of sheet metal flashing and trim.
 4. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Flashing System Wind Design Loads: Provide roofing system, including anchorage, capable of withstanding wind load design pressures applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2- Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
1. Basic Wind Speed: 147 mph 3-second gust.
 2. Importance Factor: 1.15
 3. Exposure Category: B.
- C. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
 - 1. Identification of material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 4. Details of termination points and assemblies, including fixed points.
 - 5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
 - 6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 - 7. Details of special conditions.
 - 8. Details of connections to adjoining work.
 - 9. Detail formed flashing and trim at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
 - 3. Accessories and Miscellaneous Materials: Full-size Sample.
 - 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified fabricator.
- B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

1. Leader Boxes and Roof Drainage Systems: Chapter 1; Figures 1-25F (Conductor Head), 1-26A (Through Wall Scupper), and 1-27A (Scupper Design).
 2. Gutter and Roof Drainage Systems: Chapter 1; Figures 1-5, 1-6 (Exp. Joint), 1-9 (Built-In), 1-17B (Hangers and Brackets), 1-24C (Outlet Tubes), and 1-24D (Leaf Strainers).
 3. Downspouts: Chapter 1; Figures 1-32A (Round), 1-35H (Hanger), 4-9, 4-19A, 4- 22A, and 4-22C.
 4. Copings: Chapter 3; Figures 3-1, Table 3-1, and 3-4A.
 5. Counterflashings: Chapter 4; Figure 4-3A.
 6. Roof Penetration Flashings: Chapter 4; Figure 4-13A with fastened and sealed upturned splice as detailed.
 7. Roof Vent or Pipe Penetrations: Chapter 4; Figure 4-14C.
 8. Thru-Wall Scupper: Chapter 1; Figures 1-26A and 1-26B.
- C. Preinstallation Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
 2. Review methods and procedures related to sheet metal flashing and trim.
 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
 5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.9 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755; minimum

0.0179-inch thick.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653, G90 coating designation; structural quality.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792, Class AZ50 coating designation, Grade 40; structural quality, with smooth surface.
3. Surface: Smooth, flat and mill phosphatized for field painting.
4. Exposed Coil-Coated Surface: Two-coat fluoropolymer complying with AAMA 621 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Provide color as selected by Architect from manufacturers full-range of available colors.
5. Concealed Coil-Coated Surface: Pretreat with manufacturer's standard white or lightcolored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBSmodified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT.
 - b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
 - c. Henry Company; Blueskin PE200 HT.
 - d. Metal-Fab Manufacturing, LLC; MetShield.
 - e. Owens Corning; WeatherLock Metal High Temperature Underlayment.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- C. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic,

nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

- E. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

2.4 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Cheney Flashing Company.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products Inc.
 - d. Hickman, W. P. Company.
 - e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
 - f. Keystone Flashing Company, Inc.
 - g. National Sheet Metal Systems, Inc.
 - h. Sandell Manufacturing Company, Inc.
 - 2. Factory Coated Steel Sheet: 0.019 inch thick.
 - 3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 - 4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
 - 5. Accessories:
 - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
 - 6. Finish: Mill.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
 - 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 2. Obtain field measurements for accurate fit before shop fabrication.
 - 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- H. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.
- I. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.
 - 1. Gutter Style: As shown.
 - 2. Expansion Joints: Butt type with cover plate.
 - 3. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen.
 - 4. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
 - a. Factory Coated Steel Sheet: 0.016 inch thick.
 - 5. Gutters with Girth 16 to 20 Inches: Fabricate from the following materials:
 - a. Factory Coated Steel Sheet: 0.019 inch thick.
 - 6. Gutters with Girth 21 to 25 Inches: Fabricate from the following materials:
 - a. Factory Coated Steel Sheet: 0.025 inch thick.
- B. Downspouts: Fabricate round downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
 - 1. Fabricated Hanger Style: SMACNA figure designation 1-35H.
 - 2. Factory Coated Steel Sheet; 0.016 inch thick.
- C. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes. Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.016 inch thick.

- D. Splash Pans: Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.019 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of both external and internal leg Miter corners, seal, and solder or weld watertight.
 - 1. Coping Profile: Manufacturers standard complying with specified requirements.
 - 2. Fabricate from the following materials:
 - a. Factory Coated Steel Sheet: 0.050 inch thick.
- B. Roof to Wall Transition: Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.025 inch thick.
- C. Base Flashing: Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.019 inch thick.
- D. Counterflashing: Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.019 inch thick.
- E. Flashing Receivers: Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.016 inch thick.
- F. Roof-Penetration Flashing: Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.019 inch thick.
- G. Roof-Drain Flashing: Fabricate from the following materials:
 - 1. Factory Coated Steel Sheet: 0.016 inch thick.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. General: Install underlayment as indicated on Drawings.
- B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 3. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 5. Install sealant tape where indicated.
 6. Torch cutting of sheet metal flashing and trim is not permitted.
 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
1. Coat back side of stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate [wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws] [metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance] <Insert size requirement>.
- E. Seal joints as shown and as required for watertight construction.
1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant type joints at temperatures below 40 deg F (4 deg C).
 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
- F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pretinning where pre-tinned surface would show in completed Work.
1. Do not solder aluminum sheet.
 2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 ROOF DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
- B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
 - 1. Fasten gutter spacers to front and back of gutter.
 - 2. Loosely lock straps to front gutter bead and anchor to roof deck.
 - 3. Anchor and loosely lock back edge of gutter to continuous cleat.
 - 4. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.
 - 5. Install continuous gutter screens on gutters with noncorrosive fasteners, removable for cleaning gutters.
- C. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints.
 - 1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
 - 2. Provide elbows at base of downspout to direct water away from building.
- D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant compatible with [roofing membrane] <Insert material>.
- E. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 1. Anchor scupper closure trim flange to exterior wall and seal with elastomeric sealant to scupper.
 - 2. Loosely lock front edge of scupper with conductor head.
 - 3. Seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.
- F. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch below scupper discharge.

3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
 - 1. Interlock exterior bottom edges of coping with continuous cleat anchored to substrate at 24-inch (600-mm) in accordance with coping manufacturers complying with performance requirements.

- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant.
- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section "Unit Masonry."
- C. Reglets: Installation of reglets is specified in Section 04 20 00 "Unit Masonry."

3.7 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.8 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

08 11 00

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
1. Hollow metal doors.
 2. Hollow metal frames.
 3. Sidelight frames
 4. Fire-rated door and frame assemblies.
 5. Vision lite frame trim in doors.

1.3 RELATED WORK

- A. Related Work of Other Sections:
1. Division 04 Section – Unit Masonry
 2. Division 04 Section – Exterior Stone Cladding
 3. Division 07 Section – Joint Sealants.
 4. Division 08 Section – Wood Doors.
 5. Division 08 Section – Entrances and Storefront
 6. Division 08 Section – Door Hardware.
 7. Division 09 Section – Gypsum Board Assemblies.
 8. Division 09 Section – Painting and Coating.
 9. Division 13 Section – Metal Building Systems.

1.4 SUBMITTALS

- A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.
- B. Shop Drawings: Show the following:
1. Elevations of each door design.
 2. Details of doors including vertical and horizontal edge details.
 3. Frame details for each frame type including dimensioned profiles.
 4. Details and locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of anchorages, accessories, joints, and connections.
 7. Coordination of glazing frames and stops with glass and glazing requirements.
- C. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

1.5 QUALITY ASSURANCE

- A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
 - 1. Test Pressure: Test at positive pressure in accordance with UBC Standard 7-2.
 - 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 3. Temperature-Rise Rating: Where indicated, provide doors that have a temperature-rise rating of 450 deg F maximum in 30 minutes of fire exposure.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
- B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.
- C. Store doors and frames at building site under cover. Place units on minimum 4-inch- high wood blocking. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

1.7 SEQUENCING AND SCHEDULING

- A. Submit data and schedule at earliest possible date, particularly where acceptance of schedule must precede fabrication of units that must be built into other work. Coordinate door and frame work with door hardware specified in Division 08 Section – Door Hardware.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with Project requirements, provide hollow metal door and frame units produced by one of the following:
 - 1. Amweld Building Products, Inc. (330) 527-4385.
 - 2. Curries Co. (515) 423-1334.
 - 3. Deansteel Manufacturing Co. (210) 226-8271
 - 4. The Kewanee Corp. (800) 666-4481.
 - 5. Mesker Door Co. (205) 851-6670.
 - 6. Premier Products, Inc. (318) 361-0796.
 - 7. Republic Builders Products (901) 352-3383.

2.2 MATERIALS

- A. Steel Sheet, General: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets.

- B. Hot-Rolled Steel Sheets: ASTM A 569, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Cold-Rolled Steel Sheets: ASTM A 366, Commercial Steel (CS), or ASTM A 620, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.
- D. Anchors and Accessories: Manufacturer's standard units suitable for type of wall construction, and as follows.
 - 1. Provide square profile stops with mitered corners for glazing and louvers.
 - 2. Use galvanized items for units built into exterior walls.
 - 3. Provide countersunk flat or small oval head Philips or Jackson head fasteners where exposed to view.
- E. Primer: Manufacturer's standard rust-inhibitive primer, suitable as a base for specified finish paints.

2.3 DOORS AND FRAMES

- A. General: Provide doors of sizes, thicknesses, and designs indicated.
- B. Provide the following doors and frames complying with ANSI/SDI A250.8 "Recommended Specifications for Standard Steel Doors and Frames," and as specified.
 - 1. Exterior Doors: Level 3 and Physical Performance Level A for Extra Heavy Duty, Model 2 doors, "Seamless Design," fabricated with minimum 0.053" thick (old 16 gage) hot-dip galvanized steel faces and edges, insulated "Steel Stiffened Core," with top and bottom flush end closures sealed to eliminate moisture entry into door, and with closer reinforcement.
 - 2. Interior Doors: Level 2 and Physical Performance Level B for Heavy Duty, Model 2 doors, "Seamless Design" fabricated from minimum 0.042" thick (old 18 gage) steel faces, with "Steel Stiffened Core" and with closer reinforcement.
 - 3. Exterior Frames: Level 3 and Physical Performance Level A for Extra Heavy Duty frames, fabricated from minimum 0.053" thick (old 16 gage) hot-dip galvanized steel with mitered and continuously seam welded (including rabbets and stop) corners, and with temporary spreader bar at bottom.
 - 4. Interior Frames: Level 2 and Physical Performance Level B for Heavy Duty frames, fabricated from minimum 0.042" thick (old 18 gage) steel sheet with mitered and continuously seam welded (including rabbets and stop) corners, and with temporary spreader bar at bottom.

2.4 FABRICATION

- A. General: Fabricate hollow metal door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
- B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053- inch- thick (old 16 gage), metallic-coated steel channels with channel webs placed even with top and bottom edges.
- C. Interior Door and Panel Faces: Fabricate exposed faces of doors and panels, including stiles and rails of non-flush units, from the following material:
 - 1. Cold-rolled steel sheet.

- D. Core Construction: Manufacturer's standard core construction of the type specified that produces a door complying with SDI standards.
- E. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.
- F. Clearances for Fire-Rated Doors: As required by NFPA 80.
- G. Single Acting, Door-Edge Profile: Square edge, unless beveled edge is indicated.
- H. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- I. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.
- J. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
- K. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.
 - 1. For concealed overhead door closers, provide space, cutouts, reinforcement, and provisions for fastening in top rail of doors or head of frames, as applicable.
- L. Frame Construction: Fabricate frames to shape shown.
 - 1. For exterior applications, fabricate frames with mitered or coped and continuously welded corners, rabbets, stops, and seamless face joints.
 - 2. For interior applications, fabricate frames with mitered or coped and continuously welded corners, rabbets, stops, and seamless face joints.
 - 3. Provide fully welded frames with temporary spreader bars. No open seams are acceptable.
 - 4. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; included but not limited to electric thru wire hinges, electrical raceways, door position switches, electric strikes, jamb mount card readers, and magnetic locks as noted in door hardware sets in Division 8 Door Hardware.
 - a. Electrical knock out boxes are required at door position switches, electric strikes, card readers, and middle hinge locations for all exterior locations regardless of electrical hardware specified in Division 8 Door Hardware.
 - b. Provide electrical knock out boxes with 3/4-inch knockouts.
 - c. Conduit to be coordinated and installed in field from middle hinge box and strike box to door position box.
 - d. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 8 Door Hardware.
 - e. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.
 - f. Provide field installed conduit per Division 28 section for standardized plug connectors to accommodate up to twelve (12) wires as required for electrified door hardware specified in hardware sets in Division 8 Door Hardware. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Wire nut connections are not acceptable.
- M. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for

surface-applied hardware may be done at Project site.

- N. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.
- O. Glazing Stops: Manufacturer's standard, formed from 0.032-inch- thick steel sheet.
 - 1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.
 - 2. Provide screw-applied, removable, glazing stops on inside of glass, louvers, and other panels in doors.
- P. Astragals: As required by NFPA 80 to provide fire ratings indicated.

2.5 FINISHES

- A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install hollow metal doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.
- B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 - 1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
 - 2. In concrete construction, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
 - 3. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
 - 4. Install fire-rated frames according to NFPA 80.
 - 5. For openings 90 inches or more in height, install an additional anchor at hinge and strike jambs.
 - 6. Seal open seams in exterior units to whatever extent not completed at the factory prior to painting.
- C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.
 - 1. Fire-Rated Doors: Install within clearances specified in NFPA 80.
 - 2. Smoke-Control Doors: Install to comply with NFPA 105.

3.2 ADJUSTING AND CLEANING

- A. Cleanup: Remove excess weld splatter by grinding flush with adjacent surfaces, without grinding skips or gouging parent metal. Refer to Section 09 90 00 - Paints and Coatings for surface preparation, primer and field applied finish coats.
- B. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged

areas of prime coat and apply touch up of compatible air-drying primer.

- C. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

08 12 16

INTERIOR ALUMINUM DOORS, FRAMES, AND STOREFRONT SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Aluminum door frames for interior use.
 - 2. Aluminum door frames with sidelight frame components for interior use.
 - 3. Aluminum officefront framing system for interior use.
 - 4. Aluminum and glass doors for interior use.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 08 11 13 – Hollow Metal Doors and Frames.
 - 2. Section 08 14 00 – Wood Doors
 - 3. Section 08 81 00 – Glass Glazing.
 - 4. Section 09 91 00 – Painting and Coating.

1.4 SUBMITTALS

- A. Product Data: For each type of door indicated. Include details of core and edge construction, and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
- C. Samples for Verification:
 - 1. Aluminum finish.
 - 2. Assembly of frame with specified glazing included.
- D. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE:

- A. Manufacturer Qualifications: Manufacturer shall demonstrate previous experience in manufacturing of interior aluminum door and officefront framing for a period of not less than 10 years on comparable sized project.
- B. Source Limitations: Provide aluminum frames, aluminum and glass doors, and accessories produced by a single manufacturer for each type of product indicated.

- C. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver frames and doors in cartons to provide protection during transit and storage at project site.
- B. Inspect frames and doors upon delivery for damage.
 - 1. Repair minor damage to pre-finished products by means as recommended by manufacturer
 - 2. Replace frames and doors that cannot be satisfactorily repaired.
- C. Store frames and doors at project site under cover and as near as possible to final installation location. Do not use covering material that will cause discoloration of aluminum finish.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Basis of Design Product: Raco Interior Products, Classic Series.
 - 1. 1 1/2" frame width x 5 7/16" frame depth.
- B. Subject to compliance with requirements, provide products by one of the following
 - 1. Kawneer
 - 2. Tubelite
 - 3. C.R. Laurence Co., Inc.

2.2 MATERIALS

- A. Aluminum:
 - 1. Sheet and Plate: ASTM B 209. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000- psi ultimate tensile strength.
 - 2. Extruded Bars, Rods, Shapes and Tubes: ASTM B 221. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000-psi ultimate tensile strength.
 - 3. Welding Rods and Bare Electrodes: AWS A 5.10.

- B. Steel Materials, General: Fabricate steel reinforcements and supports as follows:
 - 1. Structural Steel Plates, Shapes, and Bars: ASTM A 36, pickled when exposed to view.
 - 2. Hot-Rolled Steel Sheet and Strip: ASTM A 570.
 - 3. Cold-Rolled Steel Sheet and Strip: ASTM A 611.
 - 4. Stainless Steel Flashing: ASTM A 666, dead-soft, 0.018-inch-thick stainless steel of type selected by manufacturer for compatibility with system.
- C. Glazing as specified in Section 08 81 00 – Glass and Glazing.
- D. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; in hardness recommended by manufacturer.
- E. Framing system gaskets and joint fillers as recommended by manufacturer for joint type.
- F. Sealants: Provide structural sealants recommended by the manufacturer of the storefront system.
 - 1. Glazing sealants and fillers as specified in Section 08 81 00 – Glass and Glazing.
 - 2. Structural silicone sealant shall be specifically designed and tested for use as structural sealant.
- G. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos, formulated for 30-mil thickness per coat.

2.3 COMPONENTS

- A. Interior Door Frames, Borrowed Light Frames, and Storefront Framing:
 - 1. Fixed Throat with thicknesses indicated on drawings.
 - 2. Manufacturer's standard intermediate mullions in widths to match perimeter framing.
- B. Swinging Aluminum and Glass Interior Doors:
 - 1. Medium Stile doors with beveled glazing stops.
 - a. Standard stiles and top rails.
 - b. ADA compliant, 10" bottom rail.
 - c. 6" or Manufacturer's largest standard midrail (whichever is less) where indicated in drawings.
 - 2. Hardware per Section 08 71 00 – Door Hardware.

2.4 FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises.
- B. Finish doors at factory.
- C. Class II Clear Anodized: AAMA 611 AA--M12C22A31 Class II, minimum thickness .04 mil, acid etched, medium matte, clear anodic coating.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine project conditions and verify that project is ready for work of this section to proceed. Do not proceed with installation until unsatisfactory conditions have been

corrected.

- B. Verify wall thickness does not exceed manufacturer=s recommended tolerances of specified throat size.

3.2 INSTALLATION

- A. Comply with frame and door manufacturer's printed installation instructions and approved shop drawings. Do not attempt installation in areas where wall thickness exceeds tolerances of specified throat size.
- B. Install frames plumb and square, free from warp or twist, securely anchored to substrates with fasteners recommended by frame manufacturer. Maintain dimensional tolerances and alignment with adjacent work. Ensure joints are hairline tight and surfaces flush with adjacent components.
- C. Set all doors in correct locations as shown on the drawings, level, square, plumb and in alignment with other work in accordance with the manufacturer's installation instructions and approved shop drawings.
- D. Install glass in accordance with Section 08 80 00.

3.3 ADJUSTING AND CLEANING

- A. Protect exposed portions of aluminum surfaces from damage by plaster, lime, acid, cement, and other contaminants.
- B. Touch up marred areas so that touch-up is not visible from a distance of 4 feet. Remove and replace frames that cannot be satisfactorily adjusted.

3.4 PROTECTION

- A. Protect as required to assure that frames and doors will be without damage until Substantial Completion.

END OF SECTION

08 14 00

WOOD DOORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing manufactured flush solid core wood doors with plastic laminate finishes, of the types specified. Factory finishing and fit doors to frames and premachine doors for hardware.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 08 11 13 – Hollow Metal Doors and Frames.
 - 2. Section 08 14 00 – Aluminum Frames.
 - 3. Section 08 81 00 – Glass Glazing.
 - 4. Section 09 91 00 – Painting and Coating.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide stiles and rails constructed of two-ply hardwood material providing minimum 1,000 lb. screw withdrawal resistance per ASTM D 143/NWWDA TM-10 (now published by WDMA) and minimum 200,000 slam cycles per ANSI A 151.1/NWWDA TM-7 (now published by WDMA) without failure.

1.5 SUBMITTALS

- A. Product Data: For each type of door indicated. Include details of core and edge construction, and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate doors to be factory finished and finish requirements.
 - 4. Indicate fire-protection ratings for fire-rated doors.
- C. Samples for Initial Selection: For plastic-laminate door faces.
- D. Samples for Verification:
 - 1. Plastic laminate, 6 inches square, for each color, texture, and pattern selected.
 - 2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.
 - 3. Provide samples for each color, texture, and pattern of plastic laminate required.
 - 4. Frames for light openings, 6 inches long, for each material, type, and finish required.

- E. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE:

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.
- C. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
- D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UBC Standard 7-2 or UL 10C.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- E. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Algoma Hardwoods, Inc.
2. Eggers Industries.
3. Graham; an ASSA Abloy Group company.
4. Marshfield Door Systems, Inc.
5. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

- A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
- B. WDMA I.S.1-A Performance Grade:
1. Heavy Duty, except as otherwise specified.
 2. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces, exits, and similar rough service door locations.
- C. Particleboard-Core Doors:
1. Particleboard: ANSI A208.1, Grade LD-1, made with binder containing no ureaformaldehyde resin.
 2. Blocking: Provide wood blocking in particleboard-core doors as follows:
 - a. 5-inch top-rail blocking, in doors indicated to have closers.
 - b. 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - c. 5-inch midrail blocking, in doors indicated to have exit devices.
- D. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
- E. Mineral-Core Doors:
1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as follows:
 - a. 5-inch top-rail blocking.
 - b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - c. 5-inch midrail blocking, in doors indicated to have armor plates.
 - d. 4-1/2-by-10-inch lock blocks
 - e. 5-inch midrail blocking, in doors indicated to have exit devices.
 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 PLASTIC-LAMINATE-FACED DOORS

- A. Interior Solid-Core Doors:
1. Grade: Premium.
 2. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS.
 3. Colors, Patterns, and Finishes: As indicated in the Finish Schedule and Finish Legend on the Drawings.

4. Exposed Vertical and Top Edges: Hardwood edges for Impact-resistant polymer edging, applied after faces.
 - a. Polymer Edging Color: Same color as faces.
5. Core: Particleboard.
6. Construction: Three plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces are applied. Faces are bonded to core using a hot press.

2.4 LIGHT FRAMES

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
 1. Wood Species: Species compatible with door faces and painted to match face.
 2. Profile: Flush rectangular beads.
 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use. Paint to match door face.
- B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 1. Comply with requirements in NFPA 80 for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- C. Openings: Cut and trim openings through doors in factory.
 1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 – Glass and Glazing.
- D. Electrical Raceways: Provide raceways for standardized plug connectors to accommodate up to twelve (12) wires as required for electrified door hardware specified in hardware sets in Division 8 Door Hardware. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Wire nut connections are not acceptable.

2.6 SHOP PRIMING

- A. Doors for Opaque Finish: Shop prime doors with one coat of door manufacturer's standard wood primer. Seal all four edges, edges of cutouts, and mortises with primer.

2.7 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Finish doors at factory.

- C. Opaque Finish:
 - 1. Grade: Premium.
 - 2. Finish: WDMA OP-4 conversion varnish or OP-6 catalyzed polyurethane.
 - 3. Color: Match door face as approved by Architect.
 - 4. Sheen: Satin.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 08 71 00 – Door Hardware.
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
 - 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

08 43 13

ALUMINUM WINDOWS, STOREFRONTS, AND ENTRANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
 - 1. Exterior a storefront system, including punched fixed windows, and swing entrance doors.
 - 2. Glass and glazing in conjunction with each of the above components, as specified in Section 08 81 00.
 - 3. Steel supports for storefront systems.
 - 4. Sealants, caulking, joint fillers, gaskets, blocking, and related materials in conjunction with each of the above components and to all adjacent work.
 - 5. Anchors, inserts, reinforcements, support brackets, supplemental internal reinforcement, expansion devices, fasteners, flashings, vents, weeps, and similar elements in conjunction with each of the above components.
 - 6. Cleaning of the work of this Section during construction and final cleaning of the work of this Section.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 05 50 00 – Metal Fabrications.
 - 2. Section 07 27 26 – Fluid-Applied Membrane Air Barriers
 - 3. Section 08 12 16 – Interior Aluminum Doors, Frames, and Storefront System
 - 4. Section 08 44 14 – Glazed Aluminum Curtain Walls
 - 5. Section 08 71 00 – Door Hardware.
 - 6. Section 08 81 00 – Glass and Glazing.

1.4 REFERENCED STANDARDS

- A. Comply with applicable standards and specifications published by NAAMM, AAMA, and AA, including definitions of terms and designations not otherwise defined herein.
- B. Comply with applicable standards and recommendations by NAAMM, in "Metal Curtain Wall Specifications Manual," "Entrance Manual" and other published specifications and standards, except to the extent more stringent requirements are indicated.
- C. Comply with the "Glazing Manual" issued by the Glass Association of North America, latest editions.
- D. Aluminum Association (AA) "Standards for Anodically Coated Aluminum Alloys for Architectural Applications."

- E. Aluminum Association "Standards for Aluminum Mill Products."
- F. National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual."

1.5 DESIGN/PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
 - 5. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Glazing-to-glazing contact.
 - e. Noise or vibration created by wind and thermal and structural movements.
 - f. Loosening or weakening of fasteners, attachments, and other components.
 - g. Sealant failure.
 - h. Failure of operating units to function properly.
- B. Structural Loads: Framing member sizes and wall thickness indicated are minimums and are for detailing only. Confirm framing member sizes, wall thicknesses, and need for internal reinforcements by analyzing Project loads and in-service conditions. Provide glazed wall system framing member sizes as indicated, but not less than size and strengths required to meet or exceed the following criteria:
 - 1. System Design: Provide entrances and storefront, including anchorage, capable of withstanding windload design pressures applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
 - a. Surface Roughness Category: Exposure B
 - b. Classification of Building: Category II
 - c. Wind Basic Design Load: 147 mph @ 3second gust
 - d. Safety factor: 1.15
 - e. ASCE-7 Calculations: Refer to Structural General Notes on the Drawings.
 - f. Internal Pressure Coefficient: Indicate in the design calculations the internal pressure coefficient used in the design of exterior cladding and components.
 - 2. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
- C. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.

3. Test Durations: As required by design wind velocity but not less than 10 seconds.
- D. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- E. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.
- F. Water Penetration Under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
- G. Water Penetration Under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive windload design pressure, but not less than 6.24 lbf/sq. ft.
 1. Maximum Water Leakage: According to AAMA 501.1. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

1.6 SUBMITTALS

- A. Product Data for each product specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- B. Shop Drawings showing fabrication and installation of entrance and storefront system including plans, elevations, sections, details of components, and attachments to other units of Work. Include metal and glass thickness, details of all field connections and anchorage, fastening and sealing methods, metal finishes, location of all joints, direction of expansion of wall and related components, exposed fasteners, work to be performed by other trades which adjoins and/or is secured to storefront system components, and all other pertinent information.
 1. For installed products indicated to comply with certain design loadings, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Include certification signed and sealed by the qualified professional engineer responsible for the structural analysis preparation that the storefront system design complies with the Design/Performance Requirements specified. Submit engineering calculations and certification with first submittal of shop drawings.
 2. Show full and complete details of the entire system, related construction, general layout and elevations, glazing system, and setting blocks, connections, shims, glass types and sealant types.
 3. Show sequence of erection. Accommodate deviation and qualification to the erection sequence by General Contractor without altering the design profiles.
 4. Do not change shop drawings and data bearing Architect's final review stamp, or deviate from construction operations, unless changes and deviations are coordinated with glass manufacturer and submitted to Architect for review.
 5. Begin fabrication only after receiving shop drawings bearing Architect's final review stamp.

- C. Samples for verification of each type of exposed finish required in manufacturer's standard sizes. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.
- D. Product test reports from a qualified independent testing agency evidencing compliance of storefront system with requirements based on comprehensive testing of manufacturer's current system.
- E. Maintenance Manuals: Submit 3 copies each of detailed procedures for the periodic inspection, maintenance, and cleaning of all applicable storefront system elements, including glass and metal finishes.
- F. F. As-Built Drawings: Prior to final acceptance of the work under this Section, transmit 2 "as-built" reproducible copies of all shop drawings and engineering calculations to General Contractor for the permanent Project file. Show all components as actually fabricated and erected.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: To qualify for approval, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of storefront systems that are similar to those indicated for this Project in material, design, and extent.
- C. Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform work of this Section who has specialized in installing storefront systems similar to those required for this Project and who is acceptable to manufacturer.
 - 1. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for storefront systems, including drawings, testing program development, test-result interpretation, and comprehensive engineering analysis that shows systems' compliance with specified requirements.
 - 2. Examine and study the Drawings and Specifications to insure the work as described is complete and submit written notification to the General Contractor of all discrepancies. Direct requests for clarification of conditions from the Installer shall be sent to the General Contractor.
 - 3. Examine and study the Drawings and Specifications with regard to the surfaces and structural framing to which all applicable work in this Section is attached and anchored. Submit written notification to the General Contractor of all deficiencies and detrimental factors that would affect proper and timely installation of the work of this Section. Furnish and install supplementary parts to comply with design/performance requirements and complete the work indicated. Design and size framing sections and components to meet the design/performance requirements. Furnish and install clips and bracing for secure anchorage of the storefront system elements to the structure.
 - 4. Coordinate and verify, by measurement at the Project Site, all dimensions affecting work of this Section. Bring field dimensions that are at variance with those on the approved shop drawings to the attention of the General Contractor. Obtain decisions regarding corrective measures from the General Contractor before the start of installation of affected items. Assure compatibility of adjacent items in relationship to work of this Section.

5. Cooperate with the General Contractor in the coordination and scheduling of the work of this Section with the work of other Sections so as not to delay Job progress.
 6. Maintain design concept as shown (member sizes, basic profiles, and component alignment). Modify only as necessary to meet performance requirements.
- D. Source Limitations: Obtain each type of storefront system from one source and by a single manufacturer.
- E. Product Options: Drawings indicate size, profiles, and dimensional requirements of entrance and storefront systems and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 01 Section "Product Requirements" for substitution procedures.
1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval and only to the extent needed to comply with performance requirements. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Meetings." Review methods and procedures related to storefront system including, but not limited to, the following:
1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 2. Review structural loading limitations.
 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review required inspecting, testing, and certifying procedures.
 5. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.

1.8 DELIVERY AND STORAGE OF MATERIALS

- A. Store materials delivered to the Site in space(s) provided by the General Contractor on each floor of the building to permit easy access to and handling of the materials. Store materials neatly, properly stacked on dunnage, and protected from warping and damage. The Contractor shall not be required to move them except for installation.
1. Transport, handle, and store materials and components in a manner to preclude damage.
 2. Deliver accessory materials in manufacturer's labeled containers.
 3. Exercise care in handling and protect all materials and finishes during fabrication, shipment, storage, and erection as necessary to prevent damage to the finished surfaces.
 4. Remove all units and components that are cracked, bent, chipped, scratched, or otherwise unsuitable for installation and replace with new, approved items.

1.9 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.10 WARRANTY

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- A. Provide special project warranty as specified, agreeing to remove and replace entrance and storefront system work, including but not limited to, aluminum entrance units, storefront framing systems, and glass and glazing work which becomes unserviceable or objectionable in appearance due to failure in materials or workmanship. Warranty includes removal and replacement of related work that must be removed to properly repair or replace storefront system work.
1. Failure of materials and workmanship includes, but is not limited to, excessive leakage or air infiltration, excessive deflections, deterioration of finish of metal in excess of normal weathering, and defects in hardware and accessories, weatherstripping, sealants, deterioration of glass coating, glass breakage resulting from thermal conditions, deterioration of insulating glass unit edge seal and other components of the work. Failure of materials or workmanship of entrance units includes failures in operation of doors and hardware.
 2. Warranty period shall be 5-years for storefront system work from the Date of Substantial Completion.

PART 2 PRODUCTS

2.1 PRODUCT AND MANUFACTURER

- A. Exterior Glazed Storefront System:
1. Basis of Design: Subject to compliance with Design/Performance Requirements, provide "Trifab VG451UT Series" Center Set, Thermally Broken Storefront by Kawneer, or equivalent by Oldcastle, Acadia, Traco, Tubelite, American Products Incorporated (API), or Wausau Metal as approved by Architect.
 - a. 4 1/2" x 2" tube type system complying with Design/Performance Requirements, and with continuous sill pan with end dams below all sills.
- B. Medium Stile Entrance Doors:
1. Basis of Design: Subject to compliance with Design/Performance Requirements, provide Kawneer Medium Stile Doors, or equivalent by Oldcastle, Acadia, Traco, Tubelite, American Products Incorporated (API), or Wausau Metal as approved by Architect.
 - a. Frames integral to storefront system
 - b. Standard stiles and top rails.
 - c. ADA compliant, 10" bottom rail.
 - d. 6" or Manufacturer's largest standard midrail (whichever is less) where indicated in drawings.
 2. Hardware for Medium Stile Entrance Doors:
 - a. Continuous Geared Hinges, (1 per leaf).
 - b. Thresholds of type required to meet ADA requirements based on sill conditions of doors.
 - c. Power transfers:
 - 1) Electric Power Transfer Hinges are prohibited from use at entrance doors.
 - 2) Armored Loops may be used provided all parts of the power transfers are concealed from view when the door is closed.
 - d. Remainder of Hardware per section 08 71 00 – Door Hardware
- C. Exterior Fixed Punched Windows:
1. Product and Manufacturer (Basis of Design): Subject to compliance with Design/Performance Requirements, provide "8225TL, Fixed Thermal Windows" by Kawneer
 - a. Frame depth per manufacturer.
 - 1) 2 1/4" indicated in basis of design product.

2.2 MATERIALS

- A. Aluminum:
1. Sheet and Plate: ASTM B 209. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000- psi ultimate tensile strength.
 2. Extruded Bars, Rods, Shapes and Tubes: ASTM B 221. Provide alloy and temper recommended by manufacturer for strength, application of required finish, but not less than 22,000-psi ultimate tensile strength.
 3. Welding Rods and Bare Electrodes: AWS A 5.10.
- B. Steel Materials, General: Fabricate steel reinforcements and supports as follows:
1. Structural Steel Plates, Shapes, and Bars: ASTM A 36, pickled when exposed to view.
 2. Hot-Rolled Steel Sheet and Strip: ASTM A 570.
 3. Cold-Rolled Steel Sheet and Strip: ASTM A 611.
 4. Stainless Steel Flashing: ASTM A 666, dead-soft, 0.018-inch-thick stainless steel of type selected by manufacturer for compatibility with system.
- C. Glazing as specified in Section 08 81 00 – Glass and Glazing.
- D. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; in hardness recommended by manufacturer.
- E. Framing system gaskets and joint fillers as recommended by manufacturer for joint type.
- F. Sealants: Provide structural and weatherseal sealants recommended by the manufacturer of the structural sealant storefront system.
1. Glazing sealants and fillers as specified in Section 08 81 00 – Glass and Glazing.
 2. Structural silicone sealant shall be specifically designed and tested for use as structural sealant.
 3. Secondary seal or weatherseal silicone sealants shall be compatible with the structural silicone sealant. Weatherseal shall accommodate a 50 percent increase or decrease of joint width as measured
- G. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos, formulated for 30-mil thickness per coat.

2.3 COMPONENTS

- A. Inserts, Brackets and Reinforcements: Provide manufacturers standard high strength aluminum brackets and reinforcements where possible. Where steel units are required for inserts, higher strength or other reason, hot-dip galvanize the units after fabrication, with 2.0 oz. zinc coating, complying with ASTM A 123.
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Finish exposed portions to match glazed aluminum curtain wall.
1. Provide fasteners and accessories complying with the "Design/Performance Requirements." Provide self-locking fasteners and nuts with nylon inserts or patches as manufactured by USM Corporation, Nylok Fastener Division, or equivalent approved by Architect.
 2. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
 3. Where fasteners anchor into aluminum less than 0.125-inch thick, provide reinforcement to receive fastener threads.

4. Use exposed fasteners with countersunk Phillips screw heads finished to match framing members, unless otherwise indicated.
- C. Anchors: 3-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer. Provide hot-dip galvanized steel expansion anchors inserts complying with ASTM A 123 or ASTM A 153 requirements.
- D. Concealed Fasteners: Provide aluminum, 300 Series stainless steel or other noncorrosive metal fasteners of types proven to be compatible with the materials and items being fastened and required to
- E. Exposed Fasteners: Provide Phillips countersunk flat-head screws where exposed, unless otherwise approved or required. Finish exposed fasteners to match finish of exposed aluminum in which they occur.
- F. Shims: Provide galvanized steel (ASTM A 36 or A 283) and 300 Series stainless steel as approved by the Architect. Use aluminum or plastic shims only as approved by the Architect.
- G. Thermal Break: Provide rigid polyvinyl chloride (PVC) extrusions as required to conform to the structural performance requirements as indicated on the Drawings and specified in the "Design/Performance" paragraph.

2.4 FABRICATION

- A. General: Fabricate storefront system according to Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- B. Forming: Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
- C. Prepare components to receive concealed fasteners and anchor and connection devices.
- D. Fabricate components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
- E. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld before finishing components. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- F. Glazing Pockets: Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."
- G. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

2.5 ALUMINUM FINISH

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.

- B. Exposed Panel Finish - High-Performance Organic Finish (2-Coat Fluoropolymer): AAC12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
1. Color: As selected by Architect from manufacturer's full range. Refer to drawings for general color requirements.

2.6 METAL PRIMING

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying primer.
- B. Surface Preparation: Perform manufacturer's standard cleaning operations to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel.
- C. Priming: Apply manufacturer's standard corrosion-resistant primer immediately after surface preparation and pretreatment.
1. Paint for Carbon Steel:
 - a. Concealed Parts: One shop coat of rust inhibitive primer or zinc chromate primer; FS TT-P-645.
 - b. Exposed Parts: One shop coat of zinc rich paint; MIL-P-2103S and MIL-P-38336.
 2. Galvanizing of Carbon Steel:
 - a. Steel Sheets: FA QQ-S-775c.
 - b. Hot-dipped for Shapes, Plates, Bars, and Strip: ASTM A 123.
 3. Aluminum (Concealed Parts): One shop coat of zinc chromate primer; FS TT-P-645.
 4. Dielectric Paint Between Dissimilar Metals: One coat of bituminous paint; FS TTC-494 or MIL-P-6883A.

2.7 SEALANTS

- A. One-Part Non-Acid Curing Silicone Sealant: ASTM C 920, Type S, Grade NS, Class 25, and Uses NT, M, G, A, and, as applicable to joint substrates indicated, O; medium modulus with a tensile strength between 45-psi and 75-psi at 100% elongation when tested after 14 days at 77°F and 50% relative humidity per ASTM D 412.
1. Products: Subject to compliance with requirements, provide either General Electric "Silpruf 2000" or Dow Corning "795 Building Construction Sealant."
 2. Locations: All metal-to-metal and metal to glass dynamically moving joint locations not otherwise noted or specified, including interior sealant joints on interior side of components subject to thermal movement from exterior heat sources.
 3. Colors: As selected by Architect from manufacturer's standard colors.
- B. Narrow joint sealant conforming to AAMA Standard 803.3.
1. Tremco "Curtain Wall Sealant" conforming to AAMA Standard 809.2.
- C. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by the sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
- D. Joint Sealant Backing:

1. Closed-cell polyethylene foam rod, non-gassing.
2. Expanding foam sealant; Polytite B by Polytite Manufacturing Corp. or Polyseal by Sandell Mfg. Co.

2.8 MISCELLANEOUS MATERIALS

- A. Self-Adhesive Elastic Flashing: Protecto Wrap Co. "Ice & Water Guard" flashing tape, W. R. Grace "Perm-A-Barrier," Polyguard Products "Polyguard 650," Henry "Blueskin WP 200," or equivalent 40 mil thick rubberized asphalt self-adhesive tape. Include recommended primers.

2.9 FABRICATION

- A. General: Complete the cutting, fitting, forming, drilling, and grinding of all metal work prior to cleaning, finishing, treatment, and application of coatings. Conceal fasteners wherever possible. Fabricate and assemble components in accordance with approved shop drawings. Deviations of any nature will not be permitted without prior approval of the Architect. Minor adjustments for weather integrity or strength may be suggested for Architect's approval. In the event of controversies over design or details, the decision of the Architect will take precedence.
- B. Carefully fabricate components and assemble with proper and approved provision for thermal expansion and contraction, material and fabrication and installation tolerances, and adjoining building component tolerances and design criteria.
- C. Weld aluminum by methods and with materials recommended by the aluminum manufacturer and AWS to avoid distortion and discoloration at welds. Grind exposed welds smooth and restore mechanical finish. Remove arises from cut edges and ease edges and corners to a radius of approximately 1/64-inch.
 1. Where weld metal must be exposed before anodizing, select filler alloys to closely match the composition of the base metal. Follow parent metal manufacturer's recommendations for such filler alloys.
 2. Where concealed weldments are to be made on materials that have been previously anodized or paint coated, remove anodizing or paint film in the area of fusion prior to welding. Mask parts at weld areas during anodizing or sand clean prior to welding. Cracking or discoloring of the anodizing or paint coating on the exposed areas will not be acceptable.
- D. Fit and assemble the work at the shop to the greatest extent possible. Disassemble only as required for shipment and erection. Maintain true continuity of line and accurate relation of planes and angles. Provide secure attachment and support at mechanical joints, with hairline fit of contacting members.
- E. Where 2 or more sections of metal are used in building up members, bring contact surfaces to a smooth, true, and even surface and secured together so that the joints will be weathertight without the use of pointing material. Exposed sealants, except where shown, will not be permitted. Tolerance extrusions to eliminate edge projection and misalignment at joints.
- F. Fasteners: Provide stainless steel fasteners with self-locking devices, unless otherwise noted, and of sufficient size and strength to withstand the applicable design wind load and dead load forces with safety allowance factors as required for the specific materials.
 1. Space fasteners to develop the maximum strength of the members they secure or support.
 2. Provide washers and other accessory items of the same material as the fastener.

3. Torque-tighten all assembly fasteners (except as may be required at expansion joints) to achieve the maximum torque-tension relationship in the fastener.
 4. At expansion joints, torque-tighten fasteners so as to provide proper support of the expansion joint connection elements and free noiseless movement at the connection without rattling.
- G. Conceal fasteners unless otherwise shown or approved. Where exposed fasteners are required, provide countersunk Phillips oval head type, unless otherwise indicated. Finish exposed fasteners to match surrounding metal finish.
- H. Provide extruded aluminum removable members, such as glass stops, securely engaged into adjacent components as indicated.
- I. Exposed Cladding, Trim, Panels, and Similar Components:
1. Fabricate cladding elements with fabricated edge flanges as indicated and conforming to the flatness requirements specified. Provide backside stiffener members to maintain required flatness and structural performance.
 2. Do not exceed the following surface slope at any point, when measured at room temperature, measured from the nominal plane of the surface in its final installed position:
 - a. 1.0 deg. for surfaces having a finish of high reflectivity.
 - b. 1.25 deg. for surfaces having a finish of medium reflectivity.
 - c. 1.5 deg. for surfaces having a finish of low reflectivity.
- J. Use certified welders and make structural steel welds to conform to the requirements of the American Welding Society Specifications D1.1 "Structural Welding Code - Steel."
1. Remove dirt, grease, lubricant, and organic materials by vapor or solvent degreasing.
 2. Repair joints rejected because of welding defects only by re-welding. Remove defective welds by chipping or machining. Do not flame cut welds.
 3. Where welding is done in proximity to glass or finished surfaces, protect glass and finished surfaces from damage due to weld sparks, spatter, or tramp metal.
 4. Touch up paint welds in galvanized metal with zinc rich paint.
 5. Fill pinholes in welds and surface damage on all exposed surfaces of work visible under finished lighting condition when viewed from a distance of 6', with 2 component automotive body filler compatible with primer paint. Match adjacent metal surface finish unless otherwise indicated.

2.10 SHOP PAINTING WALL SYSTEM SUPPORT FRAMING

- A. Remove scale, rust, and other deleterious materials before the shop coat of paint is applied. Clean off heavy rust and loose mill scale in accordance with SSPC SP-2 "Hand Tool Cleaning." Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning."
- B. Apply 1 shop coat of primer paint to fabricated support framing, except apply 2 coats of paint to surfaces that are inaccessible after assembly or erection. Change color of second coat.
- C. Brush or spray on metal primer paint, at a rate to produce a uniform dry film thickness of 2.0-mils for each coat. Provide full coverage of joints, corners, edges, and all exposed surfaces.

2.11 FABRICATION QUALITY CONTROL

- A. Provide full access to Architect, Owner, General Contractor, and their authorized representatives to plants, shops, and assembly points to view and inspect the processes and methods employed in the fabrication, finishing, pre-assembling, and glazing (as applicable) of the storefront system components for this Project.

- B. Provide work true to detail with sharp, clean profiles straight and free from defects, dents, marks, indentations, waves, or flaws of any nature impairing strength or appearance, fitted with proper joints and intersections and with specified finishes.
- C. All items the Architect's, Owner's, or General Contractor's authorized representative notes to have any deficiency shall:
 - 1. Be removed from production lines.
 - 2. Not be loaded and shipped.
 - 3. Not be installed or assembled on the Project Site until repairs or replacement parts are approved by authorized representative.

PART 3 EXECUTION

3.1 EXAMINATION

- A. After lines and grades have been established by the General Contractor, but before beginning installation in any area, examine the supporting structure in the vicinity of storefront system work and report all conditions in writing to the General Contractor which would prevent the proper execution of the storefront system work or endanger its permanency.
- B. Do not proceed with installation in the affected area until unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written instructions for protecting, handling, and installing storefront system. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Seal joints watertight, unless otherwise indicated. Provide means to drain water to the exterior to produce a permanently weatherproof system.
- B. Do not cut, trim weld, or braze component parts during erection, in any manner that would damage the finish, decrease the strength, or result in visual imperfection or failure in performance of the construction.
- C. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- D. Install components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
- E. Install framing members plumb and true in alignment with established lines and grades.
- F. Install factory-assembled frame units plumb and true in alignment with established lines and grades.
- G. Anchorage: After system components are positioned, fix connections to building structure as indicated on Shop Drawings.
 - 1. Provide separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- H. Welding: Weld components to comply with referenced standard and Shop Drawings, unless

otherwise indicated. Weld in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

- I. Install glazing according to Shop Drawings. Comply with requirements of Section 08 81 00 – Glass and Glazing, unless otherwise indicated.
- J. Sealants and Related Materials: Use sealing materials in strict accordance with sealant manufacturer's printed instructions. Apply sealants only by mechanics specially trained or experienced in their use. Ensure that sealants, tapes, gaskets, separators, joint fillers, and back-up materials are physically and chemically compatible with each other and with adjacent materials. Before applying sealant, completely remove all mortar, dirt, dust, moisture, and other foreign matter from sealant bond surfaces. Clean metal surfaces with oil free solvent, such as Toluene or Xylene. Wash one small area at a time and then dry with a clean white cloth before solvent evaporates. Do not apply sealant to damp surfaces. Apply primers as required by manufacturer. Apply primer to stone bond surfaces to prevent staining. Mask adjoining surfaces when required to maintain a clean and neat appearance. Tool sealing compounds to fill the joint and provide a smooth finished surface.
 - 1. Thoroughly seal all metal-to-metal joints between elements of storefront system work by buttering joints with sealant immediately prior to the final assembly of abutting sections. Clean all excess sealant from exposed surfaces.
 - 2. Install sleeves, lugs, and related items in a full bed of sealant and seal perimeter when component is in final installed position as indicated or required by specified "Performance Requirements." Clean all excess sealant from exposed surfaces.
- K. Install component parts level, plumb, true to line, and with uniform joints and reveals. Secure to structure with non-staining and non-corrosive shims, anchors, fasteners, spacers, and fillers. Use erection equipment that will not mar or stain finished surfaces in any way.
- L. Clean debris, dust, and other substances from behind and adjacent to the storefront system work as it is erected, and provide temporary closures to prevent the accumulation of such substances in the void spaces behind the glazed window wall system.
- M. Assembly and Anchorage:
 - 1. Anchor component parts securely in place, by bolting, welding, or other permanent mechanical attachment system, which will comply with performance requirements and expected movements of adjacent parts.
 - 2. Apply a bituminous coating of approximately 30-mil dry film thickness, or other suitable permanent separator, on concealed contact surfaces of dissimilar materials, before assembly or installation.
 - 3. Set sill members and other members with joint fillers and elastomeric sealant to provide weathertight construction.
- N. Flashing: Provide flashings of the material and profiles indicated. Provide continuous flashings in longest lengths possible. Lap joints 12" minimum and seal concealed area of entire lap with curtain wall sealant. Provide mechanical fasteners to maintain contact of overlapping elements.

3.3 ERECTION TOLERANCES

- A. Provide installed storefront system components conforming with to following erection tolerances:
 - 1. Maximum Deviation for Vertical Member: 1/8-inch maximum in story height of 13- feet and 1/4-inch maximum.
 - 2. Maximum Deviation for Horizontal Members: 1/8-inch maximum in a 30-foot run.
 - 3. Maximum offset from true alignment between two abutting members shall be 1/32-

- inch. No edge projection or misalignment will be permitted.
4. Maximum joint gap or opening between removable glazing stop and adjacent member shall be 1/32-inch and/or a maximum 1/32-inch cumulative opening at both ends of removable member (1/64-inch each end).

3.4 CLEANING

- A. Clean completed system, inside and out, promptly after erection and installation of glass and sealants (allow for nominal cure of liquid sealants). Contractor shall advise General Contractor of proper and adequate protection and cleaning procedures during remainder of construction period, so that the system will be without damage and deterioration at time of acceptance.
 1. Just prior to Date of Substantial Completion, clean windows, storefronts, and entrances thoroughly and polish glass. Demonstrate proper cleaning methods and materials to Owner's maintenance personnel.
 2. If work is done to correct punch list items on windows, storefronts, or entrances, re-clean affected windows, storefronts, and entrances thoroughly and polish glass prior to final completion.
 3. Submit a "Cleaning and Maintenance Manual" listing the types of cleaning compounds, cleaning methods, and the types of sealant and glazing materials to be used for cleaning, repair, and maintenance of the work, as specified.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure windows, storefronts, and entrances are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware
2. Electronic access control system components

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section "Alternates" for alternates affecting this section.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
 - a. "Metal Doors and Frames"
 - b. "Flush Wood Doors"
 - c. "Stile and Rail Wood Doors"
 - d. "Interior Aluminum Doors and Frames"
 - e. "Aluminum-Framed Entrances and Storefronts"
 - f. "Stainless Steel Doors and Frames"
 - g. "Special Function Doors"
 - h. "Entrances"
6. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
7. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL LLC

1. UL 10B - Fire Test of Door Assemblies

2. UL 10C - Positive Pressure Test of Fire Door Assemblies
 3. UL 1784 - Air Leakage Tests of Door Assemblies
 4. UL 305 - Panic Hardware
- B. DHI - Door and Hardware Institute
1. Sequence and Format for the Hardware Schedule
 2. Recommended Locations for Builders Hardware
 3. Keying Systems and Nomenclature
 4. Installation Guide for Doors and Hardware
- C. NFPA – National Fire Protection Association
1. NFPA 70 – National Electric Code
 2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
 3. NFPA 101 – Life Safety Code
 4. NFPA 105 – Smoke and Draft Control Door Assemblies
 5. NFPA 252 – Fire Tests of Door Assemblies
- D. ANSI - American National Standards Institute
1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
 2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
 3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
 4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
 5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
 - a. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - b. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
 - a. Wiring Diagrams: For power, signal, and control wiring and including:
 - 1) Details of interface of electrified door hardware and building safety and security systems.

- 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
 4. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect's hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each hardware set cross-referenced to indications on Drawings.
 - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for hardware.
 - 8) Door and frame sizes and materials.
 - 9) Degree of door swing and handing.
 - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
 5. Key Schedule:
 - a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
 - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
 - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
 - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
 - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
 - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Final approved hardware schedule edited to reflect conditions as installed.
 - d. Final keying schedule
 - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
 - f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
 - a. Fire door assemblies, in compliance with NFPA 80.
 - b. Required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.

- c. Can inspect and verify components are in working order upon completion of installation.
 - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
 4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- B. Certifications:
 1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
 2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
 3. Electrified Door Hardware
 - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
 4. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.
- C. Pre-Installation Meetings
 1. Keying Conference
 - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.
 - 3) Requirements for key control system.
 - 4) Requirements for access control.
 - 5) Address for delivery of keys.
 2. Pre-installation Conference

- a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- b. Inspect and discuss preparatory work performed by other trades.
- c. Inspect and discuss electrical roughing-in for electrified door hardware.
- d. Review sequence of operation for each type of electrified door hardware.
- e. Review required testing, inspecting, and certifying procedures.
- f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:

- a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.07 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - a) Schlage L Series: 3 years
 - 2) Exit Devices
 - a) Von Duprin: 3 years
 - 3) Closers
 - a) LCN 4000 Series: 30 years
 - b. Electrical Warranty
 - 1) Locks
 - a) Schlage: 1 year
 - 2) Exit Devices
 - a) Von Duprin: 1 year

1.08 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
 1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

- A. Fabrication

1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer's recognized installation standards for application intended.
 2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.
- C. Cable and Connectors:
1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
 2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
 3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

- A. Manufacturers and Products:
1. Scheduled Manufacturer and Product:
 - a. Ives 5BB series
- B. Requirements:
1. Provide hinges conforming to ANSI/BHMA A156.1.
 2. Provide five knuckle, ball bearing hinges.
 3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
 4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
 5. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high

- b. Interior: Heavy weight, steel, 5 inches (127 mm) high
- 6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
- 7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
- 8. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
- 9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 CONTINUOUS HINGES

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Ives

B. Requirements:

- 1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
- 2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
- 3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
- 4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
- 5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
- 6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
- 7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.05 ELECTRIC POWER TRANSFER

A. Manufacturers:

1. Scheduled Manufacturer and Product:

- a. Von Duprin EPT-10

B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

2.06 FLUSH BOLTS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives

B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.07 COORDINATORS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives

B. Requirements:

1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes, or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

2.08 MORTISE LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Schlage L9000 series

2. Acceptable Manufacturers and Products:
 - a. No Substitute
- B. Requirements:
 1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
 2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
 3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
 4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
 5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
 6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
 7. Provide motor based electrified locksets that comply with the following requirements:
 - a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
 - b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case.
 - c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
 - d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate “hot levers” in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
 - e. Connections – provide quick-connect Molex system standard.
 8. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Lever Design: 17A

2.09 EXIT DEVICES

- A. Manufacturers and Products:
 1. Scheduled Manufacturer and Product:
 - a. Von Duprin 99/33A series
 2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide grooved touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturer's approved strikes.
9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
11. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
12. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
13. Provide electrified options as scheduled.
14. Top latch mounting: double- or single-tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
15. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.10 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Schlage/Von Duprin PS900 Series

B. Requirements:

1. Provide power supplies approved by manufacturer of supplied electrified hardware.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Provide power supplies with the following features:
 - a. 12/24 VDC Output, field selectable.
 - b. Class 2 Rated power limited output.
 - c. Universal 120-240 VAC input.
 - d. Low voltage DC, regulated and filtered.
 - e. Polarized connector for distribution boards.

- f. Fused primary input.
- g. AC input and DC output monitoring circuit w/LED indicators.
- h. Cover mounted AC Input indication.
- i. Tested and certified to meet UL294.
- j. NEMA 1 enclosure.
- k. Hinged cover w/lock down screws.
- l. High voltage protective cover.

2.11 CYLINDERS

A. Manufacturers:

- 1. Scheduled Manufacturer and Product:
 - a. Schlage Everest D (FSIC)
- 2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

- 1. Provide cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.

2.12 KEYING

A. Scheduled System:

- 1. Existing factory registered system:
 - a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

- 1. Construction Keying:
 - a. Replaceable Construction Cores.
 - 1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - a) 3 construction control keys
 - b) 12 construction change (day) keys.
 - 2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.
- 2. Permanent Keying:

- a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - 1) Master Keying system as directed by the Owner.
- b. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
- c. Provide keys with the following features:
 - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
- d. Identification:
 - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
 - 2) Identification stamping provisions must be approved by the Architect and Owner.
 - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
 - 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
- e. Quantity: Furnish in the following quantities.
 - 1) Change (Day) Keys: 3 per cylinder/core.
 - 2) Permanent Control Keys: 3.
 - 3) Master Keys: 6.

2.13 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. LCN 4010/4110/4020 series
2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. Certify surface mounted mechanical closers to meet fifteen million (15,000,000) full load cycles. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter with 11/16-inch (17 mm) diameter double heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.

5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers. When closers are parallel arm mounted, provide closers which mount within 6-inch (152 mm) top rail without use of mounting plate so that closer is not visible through vision panel from pull side.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI/BHMA Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.14 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Ives

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.15 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Ives

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.16 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:

a. Glynn-Johnson

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
2. Provide friction type at doors without closer and positive type at doors with closer.

2.17 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button or thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.18 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer:

a. Zero International

B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.19 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Ives

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.20 DOOR POSITION SWITCHES

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Schlage

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.21 FINISHES

A. FINISH: BHMA 626/652 (US26D); EXCEPT:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Aluminum Geared Continuous Hinges: BHMA 628 (US28)
3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
4. Protection Plates: BHMA 630 (US32D)
5. Overhead Stops and Holders: BHMA 630 (US32D)
6. Door Closers: Powder Coat to Match
7. Wall Stops: BHMA 630 (US32D)
8. Latch Protectors: BHMA 630 (US32D)
9. Weatherstripping: Clear Anodized Aluminum
10. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.

- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
 - 3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
 - 4. Installation Guide for Doors and Hardware: DHI TDH-007-20
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.
- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Lock Cylinders:
 - 1. Install construction cores to secure building and areas during construction period.
 - 2. Replace construction cores with permanent cores as indicated in keying section.
 - 3. Furnish permanent cores to Owner for installation.
- J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:
 - 1. Conduit, junction boxes and wire pulls.
 - 2. Connections to and from power supplies to electrified hardware.
 - 3. Connections to fire/smoke alarm system and smoke evacuation system.
 - 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
 - 5. Connections to panel interface modules, controllers, and gateways.
 - 6. Testing and labeling wires with Architect's opening number.
- K. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- L. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

- M. Closer/holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- N. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- O. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- P. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- Q. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- R. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- S. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

OPT0298960 Version 1

Hardware Group No. 103

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050T 17A L583-363	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 201

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T 17A	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 201C

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T 17A	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 203

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T 17A	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 205

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	L9080T 17A	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A DW + 4"	AA	ZER
1	EA	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

Hardware Group No. 341

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	L9040 17A L583-363 L283-722 - INDICATOR	626	SCH
1	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

-INDICATOR ON OUTSIDE OF DOOR.

Hardware Group No. 401

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	L9010 17A	626	SCH
1	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 401C

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	L9010 17A	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 403S

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	L9010 17A	626	SCH
1	EA	OH STOP	900S SERIES X SIZE & MOUNTING AS REQ	630	GLY
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 501

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	L9070T 17A	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 501C

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	L9070T 17A	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER

Hardware Group No. 710AC

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
1	EA	PANIC HARDWARE	3347A-EO-LBR LENGTH & HEIGHT AS REQ	626	VON
1	EA	PANIC HARDWARE	3347A-NL-OP-LBR LENGTH & HEIGHT AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
2	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		

Hardware Group No. 714

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	9947-EO LENGTH & HEIGHT AS REQ	626	VON
1	EA	PANIC HARDWARE	9947-NL LENGTH & HEIGHT AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
2	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A DW + 4"	AA	ZER
1	EA	GASKETING	328AA H & J	AA	ZER
1	EA	MEETING STILE	8193AA (2 PCS - 1 SET)	AA	ZER
2	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

Hardware Group No. 714A

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
1	EA	PANIC HARDWARE	3347A-EO LENGTH & HEIGHT AS REQ	626	VON
1	EA	PANIC HARDWARE	3347A-NL-OP LENGTH & HEIGHT AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
2	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		
2	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

Hardware Group No. 715

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	99-NL LENGTH AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A DW + 4"	AA	ZER
1	EA	GASKETING	328AA H & J	AA	ZER
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER

Hardware Group No. 800

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	LONG DOOR PULL	PR 9266F 36" (BACK-TO-BACK MOUNTED)	630	IVE
2	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	WALL STOP	WS406/407CCV	630	IVE
4	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 800AC

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY	628	IVE
2	EA	LONG DOOR PULL	PR 9266F 36" (BACK-TO-BACK MOUNTED)	630	IVE
2	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		

Hardware Group No. 801

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. C200

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
7	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW8	652	IVE
1	SET	AUTO FLUSH BOLT	FB31P/FB41P AS REQ	630	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	EU MORTISE LOCK	L9092T EU 17A RX CON (FAIL SECURE)	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	COORDINATOR	COR X FL X MB X HW PREPS	628	IVE
2	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
2	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER
1	EA	MEETING STILE	8193AA (2 PCS - 1 SET) (OMIT @ NON-RATED DOORS)	AA	ZER
1	EA	HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
2	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 120/240 VAC (COORDINATE PS WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS)	LGR	SCE

-INGRESS BY THE CARD READER OR KEY OVERRIDE.

-FREE EGRESS BY LEVER.

Hardware Group No. C201

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092T EU 17A RX CON (FAIL SECURE)	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	EA	GASKETING	488S PSA H & J (USE SILENCERS @ NON-RATED DOORS)	BK	ZER
1	EA	HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 120/240 VAC (COORDINATE PS WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS)	LGR	SCE

-INGRESS BY THE CARD READER OR KEY OVERRIDE.

-FREE EGRESS BY LEVER.

Hardware Group No. C701

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 CON TW8	652	IVE
1	EA	ELEC PANIC HARDWARE	RX-99-L-M996-17-FSE-CON (FAIL SECURE) LENGTH AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	SURFACE CLOSER	4011/4111 X MTG BRKT, SPCR & PLATE AS REQ	689	LCN
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE
1	EA	HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 120/240 VAC (COORDINATE PS WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS)	LGR	SCE

-INGRESS BY THE CARD READER OR KEY OVERRIDE.

-FREE EGRESS BY THE PUSH PAD.

Hardware Group No. C710AC

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-3347A-EO-LBR-CON LENGTH & HEIGHT AS REQ	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-3347A-NL-OP-LBR-CON LENGTH & HEIGHT AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
2	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		
2	EA	HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
2	EA	HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
2	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (COORDINATE PS WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS)		VON

- INGRESS BY THE CARD READER OR KEY OVERRIDE.
- FREE EGRESS BY THE PUSH PADS.

Hardware Group No. C714A

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-3347A-EO-CON LENGTH & HEIGHT AS REQ	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-3347A-NL-OP-CON LENGTH & HEIGHT AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
2	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
2	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	SET	ASTRAGAL	MEETING STILE SEAL BY DOOR MFR		
2	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
2	EA	HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
2	EA	HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
2	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC (COORDINATE PS WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS)		VON

-INGRESS BY THE CARD READER OR KEY OVERRIDE.

-FREE EGRESS BY THE PUSH PADS.

Hardware Group No. C715A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-33A-NL-OP-CON LENGTH AS REQ	626	VON
1	EA	RIM CYLINDER	20-057 ICX W/CONST. CORE	626	SCH
1	EA	FSIC CORE	23-030 EV D	626	SCH
1	EA	90 DEG OFFSET PULL	8190-O 10"	630	IVE
1	EA	SURFACE CLOSER	4111 SCUSH X MTG BRKT, SPCR & PLATE X AS REQ	689	LCN
1	SET	SEAL	PERIMETER SEAL BY FRAME MFR		
1	EA	DOOR SWEEP	8198AA	AA	ZER
1	EA	THRESHOLD	65A	A	ZER
1	EA	HARNESS (IN DOOR)	ALLEGION CONNECT TYPE & LENGTH AS REQ		SCH
1	EA	HARNESS (TO POWER SUPPLY)	CON-6W - CONNECTION LEADS		SCH
1	EA	CREDENTIAL READER	BY SECURITY CONTRACTOR		
1	EA	DOOR CONTACT	679-05 TYPE AS REQ	BLK	SCE
1	EA	POWER SUPPLY	PS902 120/240 VAC (COORDINATE PS WITH SECURITY CONTRACTOR PRIOR TO SUBMITTALS)	LGR	SCE

-INGRESS BY THE CARD READER OR KEY OVERRIDE.

-FREE EGRESS BY THE PUSH PAD.

END OF SECTION

08 81 00

GLASS AND GLAZING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing glass and glazing at the following locations indicated on the Drawings.
1. Door vision lites and sidelites.
 2. Window vision and spandrel lites.
 3. Interior vision lites.
 4. Insulated Glazing Units for Curtain Walls and Storefronts.

1.3 RELATED WORK

- A. Related Work of Other Sections:
1. Division 08 Section – Steel Doors and Frames.
 2. Division 08 Section – Wood Doors.
 3. Division 08 Section – Entrances and Storefronts.

1.4 DEFINITIONS

- A. Manufacturer: A firm that produces primary glass or fabricated glass as defined in referenced glazing publications.

1.5 DESIGN/PERFORMANCE REQUIREMENTS

- A. Design/Performance, General: Provide glazing systems that are capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following:
1. Defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thicknesses indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses and strengths (annealed or heat treated) required to meet or exceed the following criteria:
1. Glass Thicknesses: Select minimum glass thickness to comply with ASTM E1300, according to the following requirements:
 - a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet above grade, according to requirements of authorities having jurisdiction or ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade

- indicated on Drawings, whichever are more stringent.
- 1) Basic Wind Speed (33 feet above finish grade): 147 mph 3 second gust.
 - 2) Importance Factor: 1.15
 - 3) Exposure Category: B.
 - 4) Internal Pressure Coefficient: Indicate in the design calculations the internal pressure coefficient used in the design of exterior cladding and components
2. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15-degrees from vertical, and under wind action and with a load duration of 60 seconds or less.
 3. Maximum Lateral Deflection: For the following types of glass specified in Part 2 - Products of this Section and supported on all four edges, provide the thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1-inch (25-mm), whichever is less.
 - a. For monolithic glass heat-treated to resist wind loads.
 - b. For insulating glass.
 - c. For laminated glass lites.
 4. Minimum Glass Thickness for Exterior Lites: Not less than 1/4 inch.
 5. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.
- C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120-degrees F, ambient; 180-degrees F, material surfaces.

1.6 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Samples: For the following products, in the form of 12-inch- square Samples for glass and of 12-inch- long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
 1. Each color of tinted float glass.
 2. Each type of laminated glass with colored interlayer.
 3. Each sandblasted logo pattern on vision glass.
 4. For each color (except black) of exposed glazing sealant indicated.
- C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- F. Warranties: Special warranties specified in this Section.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in

material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.

- B. Source Limitations for Glass: Obtain glass through one source from a single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- D. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
 - 1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
- E. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:
 - 1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 - 2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
 - 5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.
- F. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.
 - 1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency or manufacturer acceptable to authorities having jurisdiction.
 - 2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in area, provide glazing products that comply with Category II materials, and for lites 9 sq. ft. or less in area, provide glazing products that comply with Category I or II materials.
- G. Safety Glazing: Provide safety glazing as required by IBC 2006 for hazardous locations.
 - 1. Glazing in swinging doors and sidelights.
 - 2. Glazing in sliding doors and sidelights.
 - 3. Glazing in an individual fixed or operable panel adjacent to a door where the nearest exposed edge of the glazing is within a 24-inch arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches above the walking surface.
- H. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated.

Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Sloped Glazing Guidelines."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

1.8 DELIVERY, STORAGE AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.10 WARRANTY

- A. Manufacturer's Special Warranty on Laminated Glass: Written warranty, made out to Owner and signed by laminated-glass manufacturer agreeing to furnish replacements for laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site. See Conditions of the Contract for additional warranty provisions. Provide 5-year special project warranty period for laminated glass products.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Provide clear float and tinted float glass required, produced by one of the following primary glass manufacturers.
 1. AFG Industries, Inc., Kingsport, TN (800) 251-0441
 2. Ford Glass Div., Allen Park, MI, (800) 521-6346.
 3. Guardian Industries, Carleton, MI (800) 521-9040.
 4. Pilkington Libbey-Owens-Ford, Toledo, OH (800) 526-6557.
 5. PPG Industries, Inc., Pittsburgh, PA (800) 377-5267
- B. Provide each type of processed glass (coated, laminated, heat strengthened, fully tempered, or insulated glass) required, produced by one of the following:
 1. Viracon, Inc., Owatonna, MN (800) 533-2080 (Basis of Design)
 2. HGP & Affiliates, Inc., Dallas, TX (972) 663-3800.
 3. Glass Wholesalers, Inc., Houston, TX (713) 353-5800.
 4. PPG Industries, Inc., Pittsburgh, PA (800) 377-5267
- C. Primary Float Glass Products: Provide lites of the following annealed primary glass types conforming to ASTM C 1036, including references to type, class, quality, and if applicable, form, finish, mesh and pattern. Provide heat strengthened or fully tempered glass complying with ASTM C 1048, including references to kind, condition, type, quality and class. Provide laminated glass complying with ASTM C 1172, including references to kind, condition, type, quality, and class.

- D. Clear Low-E Coated Insulating Glass Type 1 (Clear Spectrally Selective Low-E Coated Fully Tempered Insulating Vision Glass Unless Otherwise Specified or Indicated): Provide units of the following construction and physical properties:
1. Nominal Overall Thickness: 1 inch.
 2. Outer Lite: 6-mm (0.23-inch) thick clear float glass (Fully tempered where required by Code and Performance Requirements), with spectrally selective low-e coating on No. 2 surface.
 3. Insulating Unit Spacer: Manufacturer's standard hermetically sealed dehydrated 13-mm (1/2-inch) black air space and complying with ASTM E 774, Class A requirements and with manufacturer's standard 13-mm (1/2-inch) spacer.
 4. Inboard Lite Assembly: One lite of 6-mm (0.23-inch) thick clear float glass (Fully tempered where required by Code and Performance Requirements).
 5. Visible Light Transmittance: 70 percent.
 6. Exterior Visible Light Reflectance: 11 percent.
 7. Interior Visible Light Reflectance: 12 percent.
 8. NFRC Winter Night Time U-Value: 0.29
 9. NFRC Winter Argon U-Value: 0.24
 10. Solar Heat Gain Coefficient: 0.22
 11. Light to Solar Heat Gain: 1.79
 12. Basis of Design: Vitro Architectural Glass clear Solarban 60 (2), or equivalent by Viracon or Pilkington as approved by Architect.
- E. Clear Low-e Coated Insulating Spandrel Glass Type 1.1: Heat Strengthened (Or Fully Tempered) Exterior Insulating Spandrel Glass): Provide units with the following construction and physical properties:
1. Nominal Overall Thickness: 1 inch.
 2. Outer Lite: 6-mm (0.23-inch) thick clear fully tempered float glass with spectrally selective low-e coating on No. 2 surface.
 3. Insulating Unit Spacer: Manufacturer's standard hermetically sealed dehydrated 13-mm (1/2-inch) air space and complying with ASTM E 774, Class A requirements and with manufacturer's standard 13-mm (1/2-inch) spacer. Provide black painted aluminum spacer with black silicone sealant where exposed to view.
 4. Inboard Lite Assembly: One lite of 6-mm (0.23-inch) thick clear heatstrengthened (or fully tempered) float glass with ceramic coating in color as selected by Architect on No. 4 surface to match exterior appearance of Glass Type 1.
- F. Fully Tempered Clear Float Glass: Condition A, Type I, Class 1, Quality q3, Kind FT, minimum 6-mm (0.23-inch) thick.
- G. Clear 1-Hour Fire-Rated Ceramic Safety Impact Rated Glazing Material Type 7: SuperLite II-XL as manufactured by SaftiFirst, Brisbane, CA, 1-800-653-3333, or equivalent by Technical Glass Products, or Vetrotech Saint-Gobain.
1. Makeup: 6 mm (1/4-inch) clear low iron PPG Starfire inboard and outboard lites and clear fire protecting intumescent interlayer.
 2. Thickness: 1/2 inch (13 mm).
 3. Weight: 6 lbs./sq. ft.
 4. Approximate Visible Transmission: 90 percent with Starfire low iron glass.
 5. Approximate Visible Reflection: 9 percent.]
 6. Fire-Rating: 45 minutes unless otherwise indicated. Fire rating listed and labeled by UL or Warnock Hersey for fire rating scheduled at opening locations on drawings, when tested in accordance with ASTM E 152 and ASTM E 163 and UL 9 and UL 10B.
 7. Impact Safety Rating: ANSI Z97.1 and CPSC 16CFR1201 (Cat. I and II).
 8. STC Rating: Approximately 40 dB.
 9. Positive Pressure Test: UL 10C, UBC 7-2 and 7-4; passes.

- H. Mirror Glass: ASTM C 1503, Mirror Glazing quality, clear annealed float glass, 6 mm (1/4-inch) thick, with 2 coats of chemically applied silver with electrolytic copper coating (0.0002" thick), followed by 2 protective coats of clear varnish or shellac applied to silvered and coppered surface and to all mirror edges, followed by final coat of mirror backing paint.

2.2 GLAZING GASKETS

- A. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal.
1. Neoprene, ASTM C 864.
 2. EPDM, ASTM C 864.
 3. Silicone, ASTM C 1115.
 4. Thermoplastic polyolefin rubber, ASTM C 1115.
 5. Any material indicated above.
- B. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal.
1. Neoprene, ASTM C 864.
 2. EPDM, ASTM C 864.
 3. Silicone, ASTM C 1115.
 4. Thermoplastic polyolefin rubber, ASTM C 1115.
 5. Any material indicated above.

2.3 MISCELLANEOUS GLAZING MATERIALS

- A. Sealants, Tapes and Backup Materials: Provide sealants, tapes and backup materials of proven compatibility with other materials that they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience. Comply with sealant and glass manufacturer's recommendations for selecting glazing sealants and tapes that are suitable for applications indicated and conditions existing at time of installation. Provide the following chemical curing, elastomeric sealants of the base polymer and movement capability indicated.
1. Non-Structural Silicone Glazing Sealant: One-part medium modulus silicone sealant with minimum $\pm 50\%$ joint movement capability and conforming to ASTM C 920, Type S, Grade NS, Class 25, Use NT, G, A, and as applicable to use indicated, O. Acceptable manufacturer and product includes General Electric Company "Silglaze II," or Dow Corning "Dow Corning 795."
 2. Class 25 Neutral Curing Structural Glazing Sealant: Dow Corning Corporation; 799, General Electric "Ultraglaze SSG4000," or GE Silicones; UltraGlaze SSG4000AC.
 3. Structural Silicone Glazing Spacers: Continuous preformed Type I Silicone Rubber Strips 50 ± 5 Shore A durometer; designed to adhere to the structural glazing sealant.
 4. Structural Silicone Setting and Edge Blocks: Preformed Type II Silicone Rubber Blocks, 85 ± 5 Shore A durometer; designed to adhere to the structural glazing sealant.
 5. Structural sealant manufacturer shall perform adhesion evaluation tests in accordance with ASTM C 794 using the sealant to be employed on production run samples furnished concurrently with the mock-up materials as well as with production runs of material to be used in the Work. Submit a quality assurance program, in addition to the specified tests, to monitor adhesion of sealant.
 6. Glazing Tape: AAMA 806.3, 100% solids butyl tape with spacer rod; Tremco "Polyshim II" or PTI "PTI 303 Glazing Tape," except use glazing tape lite kits applicable to UL Listed (UBC 7-2 1997 and UL 10C) fire-rated glazing assembly time

ratings as produced by Zero International, or equivalent and specified as part of Section 08 71 00 - Door Hardware work.

7. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- B. Miscellaneous Glazing Materials: Provide products of material, size and shape complying with the referenced glazing standard, requirements of manufacturers of glass and other glazing materials involved for glazing application indicated, and with proven record of compatibility with surfaces contacted in installation.
 1. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
 2. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.
 3. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 4. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
 5. Mirror Mastic: Spot-application type, for 25% maximum coverage, 1/8" to 1/2" thickness; Palmer Mirro-Mastic, or equivalent approved by Architect.
 6. Mirror Clips: AISI Type 302/304 stainless steel angle clips at mirror top and bottom edges, with No. 8 mirror polished finish.

2.4 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.
- B. Exposed Glass Edges: Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with indoor and outdoor faces. Grind smooth and polish exposed glass edges.
- C. Sizes, Clearances, Bite and Tolerances: Fabricate glass to the sizes required for glazed openings indicated, with edge and face clearances, bite and tolerances complying with recommendations of glass manufacturer and the referenced glazing standard, to comply with performance requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Presence and functioning of weep system.
 3. Minimum required face or edge clearances.
 4. Effective sealing between joints of glass-framing members.
- B. Inspect each piece of glass immediately before installation, and remove lites that have observable edge damage or face imperfections from the Project Site.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GLAZING PREPARATION

- A. Clean framing members to receive glass, immediately before glazing. Remove coatings that are not firmly bonded to the substrate.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- C. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
- E. Center glass lites in each opening. Provide edge blocking to comply with requirements of referenced glazing standard, except where otherwise required by glass unit manufacturer.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where the length plus width is larger than 50 inches as follows:
 - 1. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
 - 2. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Install tapes continuously, but not

necessarily in one continuous length. Do not stretch tapes to make them fit opening.

1. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.
 2. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
 3. Do not remove release paper from tape until just before each glazing unit is installed.
- B. Apply heel bead of elastomeric sealant.
- C. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- D. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING

- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 PROTECTION AND CLEANING

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION

09 20 00

GYP SUM BOARD AND LIGHT GAGE METAL FRAMING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
 - 1. Light Gage Metal Framing (Screw type steel board framing), framing for furring, and drywall ceiling suspension systems.
 - 2. Gypsum drywall board, weather resistant gypsum sheathing board, abuse resistant gypsum board, and cementitious backing units.
 - 3. Gypsum board accessories.
 - 4. Gypsum board finishing.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Division 03 Section – Cast-In-Place Concrete.
 - 2. Division 04 Section – Unit Masonry.
 - 3. Division 05 Section – Cold-Formed Metal Framing.
 - 4. Division 05 Section – Metal Fabrications.
 - 5. Division 06 Section – Rough Carpentry for exterior plywood sheathing at mineral fiber cement siding.
 - 6. Division 07 Section – Fluid-Applied Membrane Weather Barriers.
 - 7. Division 07 Section – Joint Sealants.
 - 8. Division 07 Section – Sound Batt Insulation
 - 9. Division 08 Section – Hollow Metal Doors and Frames.
 - 10. Division 08 Section – Entrances and Storefront.
 - 11. Division 09 Section – Painting and Coating.

1.4 SUBMITTALS

- A. Product Data: Submit product data for each board material and accessory required, including specifications showing compliance with requirements.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

- B. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.
- C. References and Industry Standard Guidelines:
 - 1. Association Publications
 - a. ASTM International. ASTM C 754: Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products. West Conshohocken, PA: ASTM, 2000.
 - 2. National Gypsum Company. Gypsum Construction Guide. 7th ed. Charlotte, NC: National Gypsum Company, 2001.
 - 3. USG Corporation. The Gypsum Construction Handbook. Centennial ed. Chicago, IL: USG Corporation, 2000.
 - 4. Gypsum Association Fire Resistance Design Manual GA-600.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following:
 - 1. Metal Support Materials:
 - a. Dale Industries, Inc., Dearborn, MI, (Tel) 313-846-9400.
 - b. Dietrich Industries, Inc., Hutchins, TX., (Tel) 214-225-1100.
 - c. Gold Bond Building Products Div., National Gypsum Co., Charlotte, NC, (Tel) 704-365-0950.
 - d. Amico/Maverick Steel Corp., Ennis, TX, (Tel) 800-528-5344.
 - e. Unimast, Inc., Mansfield, TX, (Tel) 817-473 9346.
 - 2. Gypsum Board and Related Products:
 - a. G-P Gypsum Products, Decatur, GA, (Tel) 404-987-5190.
 - b. Gold Bond Building Products Div., National Gypsum Co., Charlotte, NC, (Tel) 704-365-0950.
 - c. United States Gypsum Co., Chicago, IL, (Tel) 312-321-4000.
 - 3. Direct Suspension Systems:
 - a. Armstrong World Industries, Houston, TX, (Tel) 800-448-1405.
 - b. Chicago Metallic Corp., Chicago, IL, (Tel) 312-563-4600.
 - c. National Rolling Mills, Paoli, PA, (Tel) 215-644-6700.
 - d. United States Gypsum Co., Chicago, IL, (Tel) 312-321-4000.

2.2 FRAMING AND SUPPORT SYSTEMS

- A. Light Gage Metal Framing: (Screw Type Steel Studs and Runners) ASTM C 645, fabricated

from minimum 0.0179- inch thick zinc coated steel in sizes indicated, except provide minimum 0.0296-inch thick for studs used over limiting height or when required to support wall hung heavy loads. Provide 1-1/2" x 1-1/2" angle runner at perimeter of ceiling suspension panels for support of board panel edge and extruded aluminum ceiling panel edge closure trim.

- B. Non-Fire Rated Furring Bar Suspension System for Gypsum Board Ceilings: Armstrong 7900 Board Furring System with 7945 cross tees, HD 7801 wall angle, and 8887 board furring shoe, or equivalent by Chicago Metallic, or USG. Provide galvanized steel wire hangers, ASTM A 641, soft temper, sized so that stress at 3x hanger load (ASTM C 635, Table 1, Direct Hung) is less than wire yield stress. Size hanger anchorage devices for 3x calculated hanger load, except size direct pull-out concrete inserts for 5x calculated hanger load as determined by testing (ASTM E 488) conducted by a qualified independent testing agency. Coordinate with Division 09 Section - Acoustical Ceilings.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.3 BOARD MATERIALS

- A. Gypsum Board: ASTM C 36, 5/8" thick, unless otherwise shown.
 - 1. Fire rated (ASTM C 36, Type X requirements) where required for construction shown.
 - 2. Base Layer: Gypsum board, ASTM C 442 or gypsum board, ASTM C 36.
 - 3. Weather Resistant Gypsum Sheathing: Provide 1/2-inch thick, V-type T & G long edges and square butt ends, and with fiberglass reinforced faces for improved strength and weather resistance for up to 6 months of exposure; USG "Weatherock Exterior Sheathing" or Georgia-Pacific "Dens-Glass Gold."
 - a. Sheathing Tape: Carlisle Hardcast "VaporGrip-22" joint seam, flashing and vapor barrier sealing tape with "CCW-702," "CCW-1402 Primer/Adhesion Enabler," or Hardcast "GlasGrip-658" adhesive.
 - 4. Abuse Resistant Gypsum Board (Corridor Walls, Classrooms and Other Student Access Rooms, Except Toilet and Shower Rooms): ASTM C 1629, Level 1 surface indentation and soft body impact and level 3 surface abrasion, UL Classified for fire resistance (Type X), mold resistant (ASTM D 3273); Georgia-Pacific Gypsum LLC "DensArmour Plus Abuse-Resistant Interior Panels," 5/8- inch thick.
 - 5. Cementitious Backer Units (Toilet and Shower Rooms): ANSI A118.9 and ASTM C 1288 or C 1325; U.S. Gypsum "Durock Cement Board," James Hardie Building Products "Hardiebacker," or National Gypsum Company "Permabase Cement Board."

2.4 MISCELLANEOUS MATERIALS, ACCESSORIES, AND TRIM

- A. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- B. Galvanized steel casing beads, corner beads, and other metal trim accessories as required.
- C. Joint Tape: ASTM C 475, plain or perforated.
- D. Interior Joint Compound: ASTM C 475 in two grades; one for bedding tape and filling depressions and one for topping and sanding.
- E. Joint Compound for Water Resistant Backing Board: Setting type for filling joints and treating fastener heads.

- F. Acoustical Sealant: See Section 07 92 00 – Joint Sealants.
- G. Acoustical Foam Double Stick Tape: Norton Plastics Corp., V740 Multipurpose medium density foam tape, 1/4" x 2" wide.
- H. Electrical box sound pads by Harry Lowery & Associates, Sun Valley, CA, (Tel) 818-768-4661.
- I. Acoustical Foam Gasket: Norton foam sealant tape, 1-1/2" x 1/8".

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed-on fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of gypsum board assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation, except as follows:
 - 1. Partitions With Brittle Finishes: Use stud manufacturer's published limiting heights for construction and single span conditions with a limiting deflection of L/360 and uniform transverse load values as indicated on the Drawings.
 - 2. Partitions Without Brittle Finishes, More Than 10'-0" High: Use stud manufacturer's published limiting heights for construction and single span conditions with a limiting deflection of L/240 and uniform transverse load values as indicated on the Drawings.
 - 3. Do not bridge building expansion joints with support system. Frame both sides of joints with supports as indicated.
 - 4. Install supplementary framing, blocking and bracing at terminations in the work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar work to comply with details indicated or if not otherwise indicated, to comply with applicable published recommendations of gypsum board manufacturer, or if not available, of "Gypsum Construction Handbook" published by US Gypsum Co.
 - 5. Isolate stud system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading.
 - 6. Install runner tracks at floors, ceilings, and structural walls and columns where gypsum board stud system abuts other work, except as otherwise indicated.
 - 7. Terminate partition stud system at ceilings, except where indicated to be extended to structural support or substrate above.

8. Space studs 16" o.c., unless otherwise indicated.
9. Frame door openings to comply with details indicated. If not shown, comply with applicable published recommendations of gypsum board manufacturer or of "Gypsum Construction Handbook" published by U. S. Gypsum Co. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for jack studs) at head and secure to jamb studs.
10. Frame openings other than door openings to comply with details indicated or if not indicated, in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads.
11. Space wall furring members 24" o.c., unless otherwise indicated.

3.4 INSTALLING CEILING SUPPORT SUSPENSION SYSTEMS

- A. Secure hangers to structural support by connecting directly to structure where possible; otherwise connect to inserts or other direct pullout type anchorage devices as specified.
- B. Suspend ceiling hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
 4. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 5. Do not attach hangers to steel deck tabs.
 6. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- C. Space main runners 4'-0" o.c. and space hangers 4'-0" o.c. along runners, except as otherwise shown.
- D. Level main runners to a tolerance of 1/8" in 12'-0", measured both lengthwise on each runner and transversely between parallel runners.
- E. Furring Bar Suspension Support System: Attach perimeter wall track or angle wherever support system meets vertical surfaces. Mechanically joint support members to each other and butt-cut to fit into wall track.
 1. Main Runners: Support directly from wire hangers spaced at 4' o.c.; locate not more than 6" from parallel walls and space not more than 4' o.c., between parallel walls. Install manufacturer's standard splicing device at joints.
 2. Cross Runners: Support by interlocking ends of cross runners with main runners to form 90 degree angle between intersecting runners. Locate not more than 6" from parallel walls and space not more than 24" o.c.
 3. Other Components: Provide as recommended by manufacturer for support of other work resting in, or on, ceiling.
 4. Install auxiliary framing at termination of board work, and at openings for light fixtures and similar work, as required for support of both the board construction and other

work indicated for support thereon.

- F. Carrying Channel and Rigid Furring Channel Suspension System: Attach 1-1/2" carrying channels (main runners) to hangers at maximum 48" on center. Install rigid furring channels at maximum 16" on center. Level support system to a tolerance of 1/8" in 12'-0", measured both lengthwise on each channel and transversely across adjacent parallel channels. Install auxiliary framing at termination of board work, and at openings for light fixtures and similar work, as required for support of both the board construction and other work indicated for support thereon. Cold rolled steel channels shall weigh not less than 300-lb./1000 lf. for 3/4-inch size, and 475-lb./1000 lf for 1-1/2- inch size; rust-inhibitive paint for interior locations except hot-dipped galvanized at "high humidity" areas.

3.5 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
- I. Form control and expansion joints with space between edges of adjoining gypsum panels.
- J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
 - 4. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

5. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
6. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

3.6 SINGLE LAYER APPLICATION

- A. Partition/Walls: Apply gypsum board vertically with vertical joints located over supports, but offset at least one stud space on opposite faces of partition/walls. Use maximum practical length boards to minimize end joints.
- B. Ceilings: Apply gypsum board with long dimension at right angles to supports with end joints located over supports. Use maximum practical length boards to minimize end joints. Stagger end joints in alternate courses of boards and locate as far away from center of ceiling as possible.

3.7 DOUBLE LAYER APPLICATION

- A. Mechanically Fastened Layers: Fasten both layers to supports with screws. For base layer, do not exceed 24" o.c. spacing at edges and intermediate supports, and for face layer do not exceed 16" o.c. spacing along supports of non-fire rated construction. At fire rated construction, comply with requirements of fire rated design indicated.
- B. On walls, apply both layers vertically with vertical joints staggered on opposite side of partitions and offset not less than 12" between layers.
- C. On ceilings, apply first layer as specified for single layer application prior to wall face layer application; apply face layer on ceiling, offsetting joint between layer at least one back-up member spacing in both directions.

3.8 INSTALLATION OF BOARD TRIM AND ACCESSORIES, GENERAL

- A. Where feasible, use the same fasteners, to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges by nailing or stapling in accordance with manufacturer's instructions and recommendations.
 1. Install metal corner beads at external corners of board work.
 2. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed. Provide type with face flange to receive joint compound. Install L-type trim where work is tightly abutted to other work, and install special kerf-type where other work is kerfed to receive long leg of L-type trim. Install U-type trim where edge is exposed, revealed, gasketed, or sealant filled (including expansion joints).

3.9 INSTALLATION OF GYPSUM SHEATHING

- A. Except as otherwise indicated, comply with manufacturer's instructions and industry standards for the installation of gypsum sheathing.
 1. Install 2-foot wide panels horizontally with V-grooved edge down, and with end joints on supports and staggered two support spacings where possible, but not less than one support spacing or 12-inches.
 2. Fasten at each support with four screws (spaced approximately 8-inches on center) set back 3/8-inch minimum from edge.

3. Cut boards at penetrations, edges, and other obstructions of the work; fit tight against abutting work, except provide 3/8-inch setback where non-load bearing work abuts structural elements at head and jambs.
4. Do not bridge building expansion joints with gypsum sheathing; cut and space edges to match spacing of structural support elements.

3.10 FINISHING GYPSUM BOARD ASSEMBLIES

- A. Apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fastener heads, surface defects and elsewhere as required to prepare work for decoration. Prefill open joints and rounded or beveled edges, if any, using type of compound recommended by manufacturer.
- B. Exposed Board to Receive Paint and Other Finishes (Except Tile): Apply joint compound in 3 coats (not including prefill of openings in base), and sand between last two coats and after last coat.
- C. Concealed Board: Omit third coat and sanding on concealed board work which is not indicated for board finishing or for which finishing is not required to achieve fire resistance rating, sound rating or to act as air or smoke barrier.
- D. Water-Resistant Backing Board Tiled Areas: Comply with recommendations of gypsum backing board manufacturer for treatment of joints behind ceramic tile.
 1. Treat fastener heads with water-resistant joint compound.
 2. Fill tapered edges in gypsum panels with water-resistant joint compound, embed joint tape firmly and wipe off excess compound; follow immediately with a second coat of water-resistant joint compound over taping coat, being careful not to crown the joint.
 3. Fold and embed tape in all interior angles to form true angles.
 4. In water-resistant backing board areas not to be tiled, treat fastener heads and embed tape as indicated above using water-resistant joint compound but finish with two coats of joint compound used for regular gypsum board work.
- E. Provide the following levels of gypsum board finish per ASTM C 840 and GA-214:
 1. Level 0: Gypsum board within unfinished areas; taping, floating and trim is not required.
 2. Level 1: Gypsum board within ceiling plenum areas, concealed areas, unless a higher finish is required for fire resistance rated assemblies and sound rated assemblies.
 3. Level 2: Gypsum board substrates to receive ceramic tile and similar solid finish materials.
 4. Level 3: Gypsum board ceiling and wall surfaces to receive flat and satin paint over non-textured surfaces.
 5. Level 4: Gypsum board wall surfaces to receive flat or semi-gloss paint and.
 6. Level 5: Gypsum board ceiling and wall surfaces specified to receive gloss paint and other reflective applied finishes over non-textured surfaces.

END OF SECTION

09 23 00

LATH AND PLASTER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

- A. Provide all lath and plaster work including but not necessarily limited to:
 - 1. Steel stud partition systems
 - 2. Metal furring and lathing
 - 3. Gypsum plastering.
 - 4. Portland cement plastering
- B. Related work specified elsewhere:
 - 1. Rough carpentry SECTION 06 10 00
 - 2. Fluid Applied Membrane Air Barriers SECTION 07 27 26
 - 3. Gypsum Board and Light Gage Metal Framing SECTION 092000
 - 4. Painting and Coating SECTION 099000

1.3 QUALITY ASSURANCE

- A. Where plastered assemblies with fire-resistance ratings are required to comply with governing regulations, provide materials and installation identical with applicable assemblies which have been tested and listed by recognized authorities including UL and AIA.
 - 1. Provide plaster having the same aggregate as specified for similar non-rated work, unless specified aggregate has not been tested and approved by UL for the required rating.
 - 2. Comply with FM "APPROVAL GUIDE" for rated work.
- B. Interior gypsum plaster application standard: ASTM C 842.
- C. Portland cement plastering standards: ASTM C 926 and C 1063.
- D. Allowable tolerances: for flat surfaces, do not exceed 1/4" in 8'-0" for bow or warp of surface, and for plumb or level.

1.4 SUBMITTALS

- A. Submit manufacturer's product specifications and installation instructions for each material, including other data as may be required to show compliance with these specifications.

1.5 PRODUCT HANDLING

- A. Deliver, store and protect manufactured materials to comply with referenced standards.

1.6 JOB CONDITIONS

- A. Environmental conditions: comply with referenced standards for environmental conditions.
- B. Protect contiguous work from soiling, spattering, moisture deterioration and other harmful effects which might result from plastering.

PART 2 PRODUCTS

2.1 METAL SUPPORT, FURRING, LATHING & ACCESSORY MATERIALS - GENERAL

- A. Metal and finishes: manufacturer's standard steel products with manufacturer's standard galvanized finish on steel products except as follows:
 - 1. Metal lath: rust-inhibitive paint finish on copper-bearing steel (ASTM A 659), except for exterior work and in "High Humidity" areas.
 - 2. Heavy-gauge members: rust-inhibitive paint finish on rolled channels and formed sheet metal of 16 ga. and heavier and on rods and bars of No. 7 ga. or 3/16" thickness and heavier, except for exterior work and in "High Humidity" areas.
 - 3. Exterior components: hot-dip galvanized finish; ASTM A 525 G90 for 18 ga. and lighter formed metal products, ASTM A 123 galvanized after fabrication for 16 ga. and heavier products.
 - 4. Exterior exposed plastering accessories: provide zinc alloy accessories for exterior work and work in "High Humidity" areas where not fully protected by plaster.
 - a. Zinc alloys and other metals shall not be used elsewhere.
- B. Wire ties: galvanized soft steel wire.

2.2 CEILING SUSPENSION/FURRING MATERIALS

- A. Size components to comply with referenced standards unless otherwise indicated.
 - 1. Main runners: hot-rolled or cold-rolled steel.
 - 2. Hanger wire: ASTM A 641, Class 1 galvanized.
- B. Hanger rods and flats: mild steel.
- C. Hanger anchorage devices: screws, clips, bolts, cast-in-place concrete inserts or other devices applicable to the indicated method of structural anchorage for ceiling hangers and whose suitability for use intended has been proven through standard construction practices or by certified test data. Size devices for 3 x calculated hanger loading except size direct pull-out concrete inserts for 5 x calculated hanger loading.
- D. Channel cross furring: hot-rolled or cold-rolled steel channels.
- E. Pencil rod furring: hot-rolled steel rods.

2.3 WALL/PARTITION METAL FURRING MATERIALS

- A. Screw-type furring: ASTM C 645; 25 ga., hat-shaped.
 - 1. Where shown as "Resilient", provide manufacturer's standard type designed to reduce sound transmission.
- B. Furring brackets: 20 ga. serrated-arm type, adjustable from 1/4" to 2-1/4" wall clearance for channel furring.

2.4 METAL LATHING MATERIALS

- A. Where not otherwise indicated, comply with MLSFA "TECHNICAL BULLETIN 101" and ASTM C 841 for selection of metal lath for each application indicated.

1. Product standards: comply with FS QQ-L-101.
 2. Backing: where lath is indicated to have backing, and where backing is required for machine application of plaster, provide lath with factory-applied backing of moisture-resistance paper or polyethylene film.
- B. Interior diamond mesh lath: 3.4 lbs. per sq. yd., std. mesh.
- C. Exterior diamond mesh lath: 3.6 lbs. per sq. yd., large mesh openings (approximately 1-3/8" x 3-1/8").

2.5 METAL PLASTERING ACCESSORIES & REINFORCEMENT

- A. Coordinate depth of accessory with thickness of and number of coats of plaster to be applied.
- B. Small-nose corner beads: expanded type with 2-7/8" wide flanges.
- C. Bull-nose corner bead: expanded flange type with 1" wide face, 3/4" radius.
- D. Cornerite: manufacture's standard preformed interior corner reinforcement made from 2.5 lb. per sq. yd. diamond mesh lath.
- E. Square-edged casing beads: manufacturer's standard with expanded or short flange to suit application.
- F. Two-piece control joints: manufacturer's standard roll-formed pair of casing beads with modified back flanges providing positive slip joint action and dust barrier, adjustable for joint width variation of 1/8" to 5/8".
- G. Corner reinforcements: special stucco-type woven galvanized wire corner reinforcing strips.
- H. Line wire: 18 ga. soft annealed steel wire.
- I. Fasteners: galvanized steel, of type and length suitable for adequate penetration of the substrate.

2.6 GYPSUM LATHING MATERIALS

- A. Comply with ASTM C 37, and provide 16" x 48" sheets unless otherwise indicated.
- B. Perforated type: provide perforated lath where shown and where required for compliance with applicable standards or governing regulations, otherwise provide plain lath.
- C. Insulating type: provide factory-applied bright aluminum foil back facing where shown as "Insulating".
- D. Type "X": provide fire-rated and labeled lath (ASTM C 473) where shown as "Type X".
- E. Long-length type: for vertical lathing, provide lath full length of wall/partition height.
- F. Lath thickness: 3/8", except as otherwise indicated.
- G. Lathing screws: comply with ASTM C 646.
- H. Ceiling lath suspension clips: galvanized wire clips, extending full width of lath sheet.
- I. Resilient clip: where shown as "Resilient", provide special spring type lath mounting clips,

designed to hold lath away from supports and reduce sound transmission.

- J. Lath reinforcing: 2.5 lb. per sq. yd. diamond mesh metal lath.

2.7 GYPSUM PLASTER MATERIALS

- A. Provide either neat or ready-mixed (where available) materials at Installer's option, unless otherwise indicated.
- B. Base coat plaster: gypsum.
- C. Base coat aggregate: sand.
- D. Where required fire-resistance of plaster cannot be achieved with sand aggregate, provide perlite aggregate.
- E. Finish coat plaster: gypsum gauging plaster.
- F. Finish coat aggregate: for sand float finish, provide white silica sand passing a 30 mesh screen.

2.8 PORTLAND CEMENT PLASTER MATERIALS

- A. Provide either neat or ready-mixed (where applicable) materials, at Installer's option, complying with ASTM C 926.
- B. Base-coat cement: Portland cement, ASTM C 150, Type I or IA.
- C. Base-coat aggregate: sand.
- D. Base-coat fiber: hair or fiber; mix with plaster for scratch coat on metal lath or reinforcement.
- E. Prepared finish-coat: factory-prepared finish for Portland cement plaster, type recommended by the manufacturer for the color and texture indicated.
 - 1. Texture: product to match Architect's sample.

2.9 BONDING MATERIALS

- A. Bonding additive: acrylic-based emulsion for bonding exterior and interior Portland cement plaster base-coat to solid substrates.
- B. Products: Quick-Cure Ad-Liquid (Finestone Corp.); Acrylic Admix-101 (Larsen Products Corp.); or Acryl 60 (Std. Dry Wall Prod.).

2.10 PLASTER MIXES

- A. Provide mixes in accord with applicable standards except for exceptions as indicated.
- B. Mix for exterior Portland cement plaster: include bonding additive, in accordance with manufacturer's instruction.
- C. Mix for gypsum plaster soffits: sand aggregate base coats, sand aggregate finish coat.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate work with structural ceiling work to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling hangers.
- B. Furnish concrete inserts, steel deck hanger clip and similar devices for installation well in advance of time needed for coordination with other work.
- C. Clean plaster bases and substrates to be plastered, removing loose materials, coatings and other substances which might impair the work.
- D. Etch concrete and masonry surfaces indicated for direct plastering. Wet surface, scrub with acid etch solution, and rinse thoroughly; repeat if necessary for adequate plaster bond.
- E. Apply bonding agent on interior concrete surfaces indicated for direct plastering; comply with manufacturer's instructions.

3.2 INSTALLATION OF METAL SUPPORT SYSTEMS

- A. Where lathing and metal support system abuts building structure horizontally, and where partition/wall work abuts overhead structure, isolate the work from structural movement sufficiently to prevent transfer of loading into the work from the building structure. Install slip or cushion type joints to absorb deflections but maintain lateral support.
- B. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.
- C. Install supplementary framing, blocking and bracing where work is indicated to support fixtures, equipment, services, casework, heavy trim and furnishings and similar work requiring attachment and support.

3.3 CEILING SUSPENSION SYSTEMS

- A. Secure hangers to structural support by connecting directly to structure where possible, otherwise connect to inserts, clips or anchorage devices or fasteners as indicated.
- B. Space runner channels as indicated or, if not otherwise indicated, 4'-0" o.c.; and space hangers along channels as indicated or, if not otherwise indicated, 4'-0" o.c. Level runner channels to a tolerance or 1/8" in 12'-0".

3.4 METAL FURRING

- A. Space furring members 16" o.c., except as otherwise indicated.

3.5 METAL LATHING

- A. A. Install metal lath to comply with referenced standards unless otherwise indicated.
- B. Nail self-furring diamond mesh directly to masonry and concrete substrates where shown for direct plaster application.

3.6 GYPSUM LATHING

- A. Apply gypsum lath to comply with referenced standards, except as otherwise indicated.
 - 1. Form solid external corners and "floating" internal corner reinforced with clips and cornerite to comply with manufacturer's instructions.
- B. Screw apply lath to supports.

- C. Clip lath to supports, except at location where screw-attachment of lath is indicated or required to comply with manufacturer's directions.
- D. Wire-tie long-lath gypsum lath applied vertically to horizontal channel furring on walls, to comply with manufacturer's directions.

3.7 PLASTERING ACCESSORIES

- A. Anchor each flange of accessories 8" o.c. to plaster base.
- B. Miter or cope accessory corners, and install with tight joints accurately aligned.
- C. Set accessories plumb, level and true to line, with a tolerance of 1/8" in 10'-0".
- D. Install metal corner beads at external corners.
- E. Install casing beads at terminations of plaster work, except where plaster is indicated to pass through other work and be concealed by lapping work, and except where special screens, bases or frames act as casing beads including interior metal door frames.
- F. For exterior work, set casing beads 1/4" from abutting frames and other work (for application of sealant).
- G. Where plaster abuts concrete, set casing bead 1/4" from concrete.
- H. At "Control Joints" and "Expansion Joints" set pair of casing beads back to back, with metal strip behind anchored to only one side of joint. At "Expansion Joints" space beads 1/4" apart for interior work, 3/8" apart for exterior work.
- I. Install prefabricated expansion joints of 2-piece design where shown as "Expansion Joint"; 1/4" joint width for interior work, 3/8" for exterior.

3.8 INSTALLATION OF PLASTER

- A. Mechanically mix plaster materials at the project site; do not hand mix except where small amounts are needed, using less than one bag of plaster.
- B. Grout hollow metal frames, bases and similar work occurring in plastered areas, with base-coat plaster material, and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout 6" lengths at each anchorage.
- C. Sequence plaster installation properly with the installation and protection of other work, so that neither will be damaged by the installation of the other.
- D. Plaster flush with metal frames and other built-in metal items or accessories which act as a plaster ground, unless otherwise shown. Where plaster is not terminated at metal by casing beads, cut base-coat free from metal before plaster sets and groove finish coat at the junctures with metal.
- E. Apply thickness and number of coats of plaster as indicated; or as required by referenced standards.
 - 1. Provide 3-coat plaster installation except where shown as 2-coat work.
- F. Where plaster application will be concealed by wood paneling, above suspended ceilings and similar locations, finish-coat may be omitted; where concealed behind cabinets and similar furnishings and equipment, apply finish-coat; where used as a base for adhesive application of tile and similar finishes, omit finish-coat and coordinate thickness with overall

dimensions as shown, and comply with tolerances specified.

- G. Except as otherwise indicated, apply finish-coat as follows.
 - 1. Gypsum plaster: smooth dense finish.
 - 2. Exterior Portland cement plaster: sand-float finish.
- H. Cure Portland cement plaster by maintaining each coat in a moist condition for 2 days following application; keep enclosed and fog-spray (after initial set) as required to prevent dry-out.

3.9 CUTTING & PATCHING

- A. Cut, patch, point-up and repair plaster as necessary to accommodate other work. Repair or replace work to eliminate blisters, buckles, excessive crazing and check cracking, dry-outs, efflorescence, sweatouts and similar defects, including areas of the work which do not comply with specified tolerances, and where bond to the substrate has failed.
- B. Sand smooth-troweled finishes lightly to remove trowel marks and arises.

3.10 CLEANING & PROTECTION

- A. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces which are not to be plastered. Repair floors, walls and other surfaces which have been stained, marred or otherwise damaged during the plastering work. When plastering work is completed, remove unused materials, containers and equipment and clean floors of plaster debris.
- B. Protect plaster from deterioration and damage during the remainder of the construction period.

END OF SECTION

09 30 00

TILING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
1. Thin set unglazed porcelain mosaic tile at floor and base areas indicated.
 2. Thin set mortar for thin set floor tile.
 3. Organic adhesive for wall tile installation.
 4. Unsanded grout at wall, base, and floor tile.
- B. Related Work of Other Sections:
1. Section 03 30 00 – Cast-In-Place Concrete.
 2. Section 06 10 00 – Rough Carpentry.
 3. Section 07 92 00 – Joint Sealants.
 4. Section 09 21 16 – Gypsum Board Assemblies for cementitious tile backing boards.
 5. Section 10 28 13 – Toilet Accessories.
 6. Section 10 21 13 19 – Solid Plastic Toilet Compartments.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for manufactured products and accessories.
- B. Samples:
1. Submit manufacturer's samples for each type of product.
 2. Submit grout color samples.
 3. If requested by Architect provide grouted actual tile samples, approximately 1-ft sq., of each type and color of tile and grout selected.

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Tile Selections:
1. Refer to Finish Legend on the Drawings for tile selections, sizes, color and texture required and to Finish Schedule for locations required.

2.2 SETTING MATERIALS, GROUT AND ACCESSORIES

- A. Use the following setting materials and grout in accordance with ANSI A 108 series installation specifications indicated and Tile Council of American "Ceramic Tile: The Installation Handbook".
- B. Dry-Set Mortar (Thin Set Floors): Bostik "Tile-Mate 710/713" with "Hydroment Multi-Purpose Acrylic Additive", complying with ANSI A 118.1 and ANSI A 108.5 installation specifications. Subject to compliance with requirements, provide equivalent products by C-Cure, Mapei or Texas Cement Products will be acceptable as approved.
- C. Organic Tile Adhesive (Thin Set Walls): Bostik "7001 Mastic", complying with ANSI A 136.1, Type I, and ANSI A 108.4 installation specifications. Subject to compliance with requirements, provide equivalent products by C-Cure, Mapei or Texas Cement Products will be acceptable as approved.
- D. Grout: ANSI A118.6; Laticrete 1600 Series (Unsanded), in colors as selected by Architect. Subject to compliance with requirements, provide equivalent products by C-Cure, Bostik, Mapei, or Texas Cement Products will be acceptable as approved. Install grout in accordance with ANSI A108.10 installation specifications.
 - 1. Grout Colors: Refer to Finish Legend and Finish Schedule on the Drawings for product selections, colors, sizes and locations.
- E. Metal Edge Trim: Schluter-Systems Trim. Profiles indicated in drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine the areas and conditions under which ceramic tile work is to be applied and do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 PREPARATION

- A. Preparation of Subfloors: Prior to start of applying ceramic tile work, broom clean, or vacuum surfaces to be covered and inspect the subfloor. Start of application operations will indicate acceptance of surface conditions and full responsibility for the completed work.

3.3 TILE BACKING PANEL INSTALLATION

- A. Install cementitious backer units and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.4 INSTALLATION

- A. Comply with the applicable parts of ANSI A 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile" and the Tile Council of America "Ceramic Tile: The Installation Handbook".
 - 1. Dry-Set (Thin-Set) Floor Tile and Glass Wall Tile: ANSI A108.5.
 - 2. Organic Adhesive Set Wall Tile: ANSI A 108.4.
 - 3. Tile Set in Portland Cement Mortar Bed: ANSI A 108.1.
 - 4. Sanded and Dry-Set Tile Grout: ANSI A108.10
- B. Handle, store, mix, and apply proprietary setting and grouting materials in compliance with the manufacturer's instructions.

- C. Extend tile work into recesses and under fixtures to form a complete covering without interruptions. Terminate work neatly at obstructions, edges, and corners without disruption of pattern or joint alignment.
- D. Jointing Pattern: Lay tile with joint pattern to produce design indicated. Align joints on floor, base, walls, and trim. Lay out tile work and center tile field in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform grouted joint widths.
- E. Expansion and Control Joints: Provide where shown, and as recommended in the TCNA "Handbook for Ceramic Tile Installation". Install removable strips of the same depth as the finished tile system. Remove strips after grouting and curing operations. Refer to Section 07 92 00 for sealants.

3.5 GROUT INSTALLATION

- A. Use unsanded cement grout for grouting wall and floor tile joints.
- B. Use sanded cement grout for grouting large format tile.

3.6 CLEANING

- A. Unglazed tile may be cleaned with acid solutions only when permitted by the tile and grout manufacturer's printed instructions, but not sooner than ten days after installation.
- B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and other defective tile work.
- C. Protection: Protect installed ceramic tile work with Kraft paper or other heavy covering during the construction period to prevent damage and wear.

END OF SECTION

09 51 00

ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
 - 1. Exposed tee suspension system and lay-in acoustical panels.
 - 2. Acoustical ceiling trim and accessories, including edge trim for ceiling clouds.
 - 3. Additional hanger wires to support mechanical and electrical fixture that bear on suspension grid.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 09 21 16 – Gypsum Board Systems: Drywall suspension systems.
 - 2. Section 09 90 00 – Painting and Coating.
 - 3. Division 23 and 26 Sections - Mechanical and Electrical Fixtures Installed in ceilings.

1.4 DESIGN/PERFORMANCE REQUIREMENTS

- A. Comply with ASTM C 635 for materials and ASTM C 636 for installation. Where fire rated assemblies are indicated, comply with the requirements of the UL designs shown.
 - 1. Provide lighting fixture protection in accordance with UL requirements for the design indicated.
 - 2. Provide hanger wires as recommended by the suspension system manufacturer to comply with the structural classification specified (ASTM C 635), but not less than 12-gage galvanized wire (ASTM A 641).
 - 3. Direct wire tie to structure or provide attachment devices sized for not less than 5x design loads involved as determined by testing (ASTM E 488) conducted by a qualified independent testing agency.

1.5 SUBMITTALS

- A. Submit manufacturer's product data and samples showing compliance with specified requirements.

1.6 QUALITY ASSURANCE

- A. Acoustical Panel Standard: Comply with ASTM E 1264.
- B. Metal Suspension System Standard: Comply with ASTM C 635.
- C. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.

- D. Fire-Test-Response Characteristics:
 - 1. Surface-Burning Characteristics: Acoustical panels complying with ASTM E 1264 for Class A materials, when tested per ASTM E 84 and a smoke-developed index of 450 or less.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size units equal to 2.0 percent of quantity installed, but not fewer than two full cartons.
 - 2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed, but not fewer than two full cartons each.

PART 2 PRODUCTS

2.1 CEILING SUSPENSION GRIDS

- A. Non-Fire Rated Exposed Grid Suspension System (Grid for Ceiling Type 1): Provide Armstrong "Prelude XL" suspension system for 4' x 4' module, or equivalent by Chicago Metallic, Donn or USG Interiors as approved. Provide system complying with ASTM C 635 intermediate-duty requirements, with 1-1/2" deep main and cross runners, and 15/16" wide smooth matte white painted aluminum cap and 15/16" wide angle moldings.

2.2 ACOUSTICAL PANELS

- A. Acoustical Lay-In Panels (Lay-In Panel Type 1): Armstrong "Cortega Square Lay-in" design, Item No. 770, 24" x 24" x 5/8" thick, 0.50 NRC, 33 CAC, 0.82 Light Reflectance, Class A Flame Spread, 1 year sag resistance warranty, white standard finish, with square edges on 4 sides for Type 1 suspension grid specified in this Section or equivalent by USG Interiors, Radar, ClimaPlus, Item 2210.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Install non-fire rated assemblies in accordance with manufacturer's instructions; requirements of Article 2 "Installation of Components" of "Standard Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels" ASTM C 636; and as specified.
 - 2. Hangers: Space not more than 6-inch from each end and not more than 4-feet on center between ends of members to be supported. Provide additional hangers as required to prevent eccentric deflection or rotation of supporting runners.
 - 3. Moldings: Install where ceilings meet vertical surfaces. Cut and bend to conform to outside corners; cut and butt at inside corners.
 - 4. Do not bear supporting members on walls or partitions.
- B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders.
- C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means. Where width

of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices.

1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
 2. Do not attach hangers to steel deck tabs or to steel roof deck.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate with concealed fasteners at intervals not more than 16-inches (400-mm) on center and not more than 3-inches from ends, leveling with ceiling suspension system to a tolerance of 1/8-inch in 12-feet. Miter corners accurately and connect securely.
- E. Exposed Grid Systems:
1. Support main runners directly from hangers. Space main runners to support acoustic panels and other work resting in, or on, the ceiling, comply with performance requirements. Provide additional hanger wares at all four corners of grid surrounding lay-in light fixtures and other heavy loads supported directly by ceiling grid. Interlock cross- runners with either main runners or with crossrunners structurally classified as main runners.
 2. Install angle type moldings with exposed leg in same plane as bottom flange of runners.
 3. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit. Install square edge panels to rest on flanges of grid tees with border units supported by moldings. Install acoustic units in accordance with manufacturer's printed applicable instructions and recommendations only when:
1. Exterior openings have been closed and roofs are weathertight.
 2. Mechanical, electrical, and other work above ceilings has been completed.
 3. Wet work has been installed.
 4. Temperature and relative humidity levels comply with acoustic material manufacturer's recommendations.
- G. Cleaning and Repairs: Clean exposed surfaces; comply with manufacturer's instructions. Remove and replace damaged units and members.

END OF SECTION

09 68 00

CARPETING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing:
 - 1. Modular carpet tile.
- B. Related Work of Other Sections:
 - 1. Division 03 Section "Cast-In-Place Concrete."
 - 2. Division 09 Section "Resilient Flooring" for resilient wall base and accessories installed with carpet.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature for each type of carpet and accessory required.
- B. Shop Drawings: Submit seaming diagrams for the entire work
- C. Samples: Submit samples not less than 12" square of each different type of carpet and not less than 12" long of each different type of accessory as requested by Architect.
- D. Product Schedule: Use same designations indicated on Drawings.
- E. Maintenance Data: For carpet s to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm with not less than 5 years successful experience in carpet installations similar in size and type to carpeting work required for this project.
- B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Field Measurements: Measure each space to receive carpeting, as a basis for supplying, cutting, and seaming the carpet. Do not scale the Architect's drawings or calculate sizes from indicated dimensions.

1.5 SEQUENCING AND SCHEDULING

- A. Sequence and schedule carpeting with other work to minimize the possibility of damage and soiling of carpet during the remainder of the construction period.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.7 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet s until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet s over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Interface, LLC.
 - 2. Milliken & Company.
 - 3. Mohawk Group (The); Mohawk Carpet, LLC.
 - 4. Tandus; a Tarkett company.

2.2 CARPET TILE

- A. Color and Pattern: As selected by Architect from manufacturer's full range.
- B. Fiber Content: 100 percent nylon 6.
- C. Fiber Type: Antron.
- D. Pile Characteristic: Tufted-loop pile.
- E. Pile Thickness: 1/2 for finished carpet tile according to ASTM D6859.
- F. Backing: Performance backing. Seam sealers and chair pads shall NOT be required to maintain the warranty.
- G. No latex backing shall be used.
- H. Total Weight: 26 oz./cu. yd for finished carpet tile.
- I. Size: 24 by 24 inches.
- J. Applied Treatments:
 - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.

2.3 BROADLOOM CARPET

- A. Color and Pattern: As selected by Architect from manufacturer's full range.
- B. Fiber Content: 100 percent nylon 6.
- C. Fiber Type: Antron.
- D. Pile Characteristic: Tufted-loop pile.
- E. Pile Thickness: 1/2 for finished carpet tile according to ASTM D6859.
- F. Backing: Performance backing. Seam sealers and chair pads shall NOT be required to maintain the warranty.
- G. No latex backing shall be used.
- H. Total Weight: 26 oz./cu. yd for finished carpet tile.
- I. Size: Per manufacturer's standard, but no less than 12 feet wide.
- J. Applied Treatments:
 - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.

2.4 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cementbased formulation provided or recommended by carpet manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended by carpet manufacturer for releasable installation.
 - 1. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
- C. Accessories: Provide Mercer "Royal Commercial C/E" No. 101 carpet bar and "Imperial Reducer" No. 101 vinyl reducing strip, or approved equivalent.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet manufacturer.
 - 2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast- In-Place Concrete" for slabs receiving carpet.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates indicated to receive carpet installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

- A. Installation Method: As recommended in writing by carpet manufacturer.
- B. Maintain dye lot integrity. Do not mix dye lots in same area.
- C. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- D. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- F. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet :
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 - 2. Remove yarns that protrude from carpet surface.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer.

END OF SECTION

09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes surface preparation and the application of painting and coating systems on the following substrates:
1. All exterior ferrous metals, except as specified.
 2. All exterior non-ferrous metals, except as specified.
 3. Exterior concrete and plaster with painted finish.
 4. Interior wood with painted finish.
 5. All interior ferrous metals, except as specified.
 6. All interior non-ferrous metals, except as specified.
 7. Interior concrete masonry with painted finish.
 8. Interior concrete and plaster with painted finish.
 9. Interior gypsum drywall with painted finish.
 10. All prime coated hardware and other factory primed metal items.
 11. All prime coated hardware and other factory primed metal items.
 12. Exposed fire protection piping, valves and standpipes, excluding sprinkler heads, valve tags, name plates, and exposed operating components of motors and pumps.
 13. Exposed pipe, pipe hangers and supports, heat exchangers, tanks, piping and equipment insulation, plumbing and ductwork, motor shafts and mechanical equipment within garage and central plant rooms. Painting work excludes similar equipment located in mechanical fan (AHU Equipment) rooms.
 14. All metal grilles, except anodized aluminum, unless otherwise indicated.
 15. Exposed conduit, raceway, boxes, switchgear and electrical cabinets, excluding items located in mechanical fan (AHU Equipment) rooms.
 16. Items normally requiring painting or finishing, or which are indicated to be painted or finished.
 17. Where an item is not specifically mentioned, paint same as similar adjacent materials or surfaces.
- B. Make test patches to verify coating system compatibility and adhesion over existing coatings and surfaces.
- C. Do not include painting of:
1. Prefinished or factory finished items (e.g., shop finished woodwork and casework, acoustic materials, and similar items).
 2. Aluminum, copper, chromium and other plated finishes.
 3. Concealed surfaces in concealed and inaccessible areas including furred-areas, pipe chases, duct shafts, and similar spaces.
 4. Operating parts of fire protection, plumbing, mechanical, and electrical equipment, including sensing devices, motor and fan shafts, and sprinkler heads.
 5. Code required labels and nomenclature plates.

6. Exposed data and communication wiring and wiring devices.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 1. Section 03 30 00 "Cast-in-Place Concrete."
 2. Section 04 20 00 "Unit Masonry" for loose lintels, anchor bolts, and other items built into unit masonry.
 3. Section 05 12 00 "Structural Steel Framing" for shop priming of steel framing substrates.
 4. Section 05 31 00 "Steel Decking" for touch-up painting of steel decking welds.
 5. Section 05 50 00 "Metal Fabrications" for shop priming of metal fabrication substrates.
 6. Section 06 40 00 "Architectural Woodwork" for shop finishing of woodwork items.
 7. Section 07 62 00 "Sheet Metal Flashing and Trim" for factory coil-coated materials.
 8. Section 07 70 00 "Roof Accessories and Specialties."

1.4 DEFINITIONS

- A. Painting and Coating Systems: Include coating system materials such as primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats. Paint and coating work includes surface preparation and cleaning, primer touch-up of shop primed items, repair of existing coatings (including barrier coats required to properly apply new coating systems), field priming and painting exterior and interior material, equipment and appurtenances.
- B. Gloss Levels:
 1. Gloss Level G1 (Traditional Matt Finish – Flat): Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
 2. Gloss Level G2 (Velvet): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
 3. Gloss Level G3 (Traditional Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
 4. Gloss Level G4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
 5. Gloss Level G5 (Traditional Semi-Gloss): 35 to 70 units at 60 degrees, according to ASTM D 523.
 6. Gloss Level G6 (Traditional Gloss): 70 to 85 units at 60 degrees, according to ASTM D 523.
 7. Gloss Level G7 (High Gloss): More than 85 units at 60 degrees, according to ASTM D 523.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 1. Submit Samples on rigid backing, 8 inches square.
 2. Step coats on Samples to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
 5. Resubmit samples until required color sheen and texture are approved.

- D. Application Schedule: Submit a schedule of paint system exposure, substrates and painting manufacturer's product data for barrier, prime, intermediate and topcoats, application instructions and application equipment recommended by painting manufacturer for application methods scheduled. For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. VOC content.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.7 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- B. Quality Grade: Provide manufacturer's best quality trade sale paint material of coating types specified. Use only material Manufacturer's containers with intact labels with product identification.
- C. Coating Systems: Provide primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.
- D. Color Designations and Selections: Subject to compliance with requirements, names used to designate colors are not intended to imply that manufacturers or products named are required to the exclusion of specified products of other manufacturers. Match colors indicated by reference to manufacturer's standard color designations.
- E. Pigments: Use color pigments that are pure, non-fading, suitable for substrates and service indicated. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint by weight. This limitation is extended to interior surfaces and those exterior surfaces, such as stairs, decks, porches, railings, windows, and doors that are readily accessible to children under 7 years of age.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.9 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Coating Systems Products: Subject to compliance with requirements, provide products of one of the following for each substrate indicated:
 1. Benjamin Moore & Co.(Moore)
 2. PPG Paints. (formally Pittsburg Paints & Glidden Professional (GP)
 3. Pratt & Lambert (P & L)
 4. Sherwin-Williams Company (The) (S-W)
 5. Behr Process Corporation (Behr)
- B. Basis of Design: Refer to color schedule for Basis of Design paint selection.

2.2 PAINT, GENERAL

- A. Material Compatibility:
 1. Provide materials for use within each paint substrate system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated
- B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 1. Flat Paints and Coatings: 50 g/L.
 2. Nonflat Paints and Coatings: 150 g/L.
 3. Dry-Fog Coatings: 400 g/L.
 4. Primers, Sealers, and Undercoaters: 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 7. Pretreatment Wash Primers: 420 g/L.
 8. Floor Coatings: 100 g/L.
 9. Shellacs, Clear: 730 g/L.
 10. Shellacs, Pigmented: 550 g/L.
- C. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Colors: As indicated in a color schedule.

2.3 EXTERIOR PAINTING SYSTEMS AND MATERIALS

A. Exterior Ferrous Metal:

1. Latex Semi-Gloss Enamel: 2 finish coats over primer.
 - a. Primer: Rust Inhibitive Latex Primer.
 - 1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
 - 2) Benjamin Moore: Acrylic Metal Primer M04
 - 3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
 - 4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
 - b. First and Second Finish Coats: Exterior Semi-Gloss Latex Enamel.
 - 1) PPG: Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel
 - 2) Benjamin Moore: DTM Acrylic Semi-Gloss M29
 - 3) Sherwin Williams: Pro Industrial 0 VOC Acrylic Semi-Gloss
 - 4) Behr: Direct To Metal Semi-Gloss Paint 3200

B. Exterior Non-Ferrous Metal (Zinc Coated Steel and Aluminum):

1. Latex Semi-Gloss Enamel: 2 finish coats over primer.
 - a. Primer: Latex Galvanized Metal Primer.
 - 1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
 - 2) Benjamin Moore: Acrylic Metal Primer M04
 - 3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
 - 4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
 - b. First and Second Finish Coats: Exterior Semi-Gloss Latex Enamel.
 - 1) PPG: Devflex 4216HP High Performance Waterborne Acrylic Semi-Gloss Enamel
 - 2) Benjamin Moore: DTM Acrylic Semi-Gloss M29
 - 3) Sherwin Williams: Metalatex Semi-Gloss Enamel B42W110
 - 4) Behr: Direct To Metal Semi-Gloss Paint 3200

C. Exterior Concrete:

1. Acrylic Low Luster (Flat) Elastomeric Masonry Coating: 2 coats over alkali resistant primer with total dry film thickness not less than 2 mils
 - a. Primer Coat: Exterior Latex Flat Paint.
 - 1) PPG: Perma-Crete 4-603 Int/Ext Alkali Resistant Primer
 - 2) Benjamin Moore: Moorcraft Super Spec Exterior Flat 180
 - 3) Sherwin Williams: Loxon Masonry Primer A24W8300
 - 4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
 - b. Finish Coats: Two rolled-on or brushed-on coats of elastic masonry coating.
 - 1) PPG: Perma-Crete Pitt-Flex 4-110 Elastomeric Costing
 - 2) Benjamin Moore: Moorlastic Acrylic Elastomeric Waterproof Coating Flat 056
 - 3) Sherwin Williams Loxon A24W350 Topcoat or Sherlastic Elastomeric A5-100
 - 4) Behr: Exterior Elastomeric Masonry Stucco & Brick Paint 68

2.4 INTERIOR PAINTING SYSTEMS AND MATERIALS

A. Interior Wood - Painted:

1. Latex Eggshell Low Odor Finish: 2 finish coats over primer.
 - a. Primer: Latex-Based Interior Low-Odor White Primer.
 - 1) PPG: Seal Grip 17-921 Latex Primer
 - 2) Benjamin Moore: Eco Spec Interior Latex Primer Sealer 231
 - 3) Sherwin Williams: Pro Green 200 Low Odor VOC Primer B28W600
 - 4) Behr: Premium Plus All-In-One Primer & Sealer 75

- b. First and Second Finish Coats: Latex-Based Interior Eggshell Enamel.
 - 1) PPG: Ultra Hide 250 1402 Eggshell (Pure Performance 9-300 Eggshell 0VOC)
 - 2) Benjamin Moore: Eco Spec Interior Latex Eggshell Enamel 223
 - 3) Sherwin Williams: Pro Green 200 Low Odor VOC Eg-Shell B20W651
 - 4) Behr: Behr Pro i300 Interior Eggshell 330

- B. Interior Ferrous Metal:
 - 1. Latex Semi-Gloss Low Odor Finish: 2 finish coats over primer.
 - a. Primer: Latex-Based Interior Low-Odor White Primer.
 - 1) PPG: Speedhide 6-2 Interior Latex Sealer
 - 2) Benjamin Moore: Eco Spec Interior Latex Primer Sealer 231
 - 3) Sherwin Williams: Pro Green 200 Low Odor Low VOC Primer B28W600
 - 4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
 - b. First and Second Finish Coats: Latex-Based Interior Semi-Gloss Enamel.
 - 1) PPG: Speedhide 6-500 Semi-Gloss (Pure Performance 9-500 Semi Gloss 0VOC)
 - 2) Benjamin Moore: Eco Spec Interior Latex Semi Gloss 224
 - 3) Sherwin Williams: Pro Green 200 Latex Semi-Gloss B31W651
 - 4) Behr: Behr Pro i300 Interior Semi-Gloss 370

- C. Interior Non-Ferrous Metal (Zinc Coated Steel and Aluminum):
 - 1. Latex Semi-Gloss Low Odor Finish: 2 finish coats over primer.
 - a. Primer: Latex-Based Interior Low-Odor White Primer.
 - 1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
 - 2) Benjamin Moore: Eco Spec Interior Latex Primer Sealer 231
 - 3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
 - 4) Behr: Premium Plus Multi-Surface Primer & Sealer 436
 - b. First and Second Finish Coats: Latex-Based Interior Semi-Gloss Enamel.
 - 1) PPG: Ultra Hide 250 1406 Semi-Gloss
 - 2) Benjamin Moore: Eco Spec Interior Latex Semi Gloss 224
 - 3) Sherwin Williams: Pro Green 200 Latex Semi-Gloss
 - 4) Behr: Behr Pro i300 Interior Semi-Gloss 370
 - 2. Primer/Waterborne Dryfall Topcoat (Interior Exposed Conduit, Electrical Boxes, Piping, Ductwork, Hangers and Hanger Wire, and Steel Deck):
 - a. Surface Preparation: Solvent clean in accordance with SSPC SP1. Use clean tack cloth. All surfaces must be clean and dry.
 - b. Primer: Water based metal primer or alkyd metal primer tinted to match topcoat.
 - 1) PPG: Devflex 4020PF Direct to Metal Primer & Flat Finish
 - 2) Benjamin Moore: Universal Metal Primer M07
 - 3) Sherwin Williams: Pro Industrial Pro Cryl Universal Primer B66W310
 - 4) Tnemec: Spra-Saf EN Series 30
 - 5) Behr: Premium Plus Multi-Surface Primer & Sealer 436
 - c. Waterborne Acrylic Dryfall Finish: Provide one sprayed on coat of one of the following:
 - 1) PPG: Speedhide Super Tech Interior Dry-Fog Flat Latex 6-723XI
 - 2) Benjamin Moore: Sweep-Up Spray Latex Flat M53
 - 3) Sherwin Williams: Waterborne Acrylic Dryfall B42W2 (SG)
 - 4) Tnemec: Spra-Saf EN Series 30
 - 5) Behr: Behr Pro Dryfall 890 Flat White Base, 891 Flat Black

- D. Interior Concrete Masonry Units:
 - 1. Acrylic Epoxy Gloss Finish: 1 finish coat over filled surface with a total dry film thickness not less than 2.0 mils, excluding block filler.

- a. Filler Coat: High-performance latex block filler tinted to match topcoat. Apply at a rate to ensure complete coverage with pores filled.
 - 1) PPG: Speedhide Int/Ext 6-15 Acrylic Block Filler
 - 2) Benjamin Moore: Latex Block Filler M88
 - 3) Sherwin Williams: Heavy Duty Block Filler (B42W46)
 - 4) Behr: Behr Pro Block Filler Primer 50
 - b. Finish Coat: Two Part Low-Odor Acrylic Epoxy.
 - 1) PPG: Pitt-Glaze WB 16-551 High Solid Acrylic Epoxy; 2.25 - 2.7 mils DFT. VOC: Maximum 1.39 lb. /gal.
 - 2) Benjamin Moore: Acrylic Epoxy Coating M43/M44; 1.5 mils DFT/coat VOC: 1.86 lb. /gal
 - 3) Sherwin Williams: Water Based Epoxy (B70-200 Series) VOC: Maximum 1.50 lb. /gal.
 - 4) Behr: Behr Pro Pre-Catalyzed Waterborne Epoxy Semi-Gloss HP150; 1.5-2.0 mils DFT; VOC: <10 g/L
- E. Interior Gypsum Drywall Systems:
- 1. Egg-Shell Prime Coat/Water Based Epoxy Topcoats (Wall Areas): 2 finish coats over primer.
 - a. Primer: Waterborne epoxy, acrylic latex, or alkyd metal primer tinted to match topcoat.
 - 1) Sherwin Williams: ProMar 200 Latex Primer
 - a) VOC – Lb./Gal: 0.71
 - b) Dry Film Thickness – Mils: 1.0 to 1.1
 - b. Finish Coats: Two component low-odor acrylic epoxy. Provide two individual sprayed or rolled on coats with minimum 4 hour curing prior to recoating.
 - 1) Sherwin Williams : B73-360/B73v300 Series
 - a) VOC – Lb./Gal: 1.5
 - b) Dry Film Thickness – Mils: 2.5 to 3.0
 - 2) Tnemec Series 114 H. B.
 - a) VOC – Lb./Gal: 1.88 to 2.20
 - b) Dry Film Thickness – Mils: 4.0 to 6.0
 - 3) Behr: US Coatings AquaGrip 2600 Water Based Epoxy Semi-Gloss
 - a) C – Lb./Gal: .8
 - b) Dry Film Thickness – Mils: 2.0 to 5.0
 - 2. Cut Shellac Varnish Sealer or Alkyd Based Wall Primer (Wall Areas to Receive Wall Covering): 1 primer coat with a dry film thickness of 0.9 mils.
 - a. Primer: Cut Shellac Varnish or Latex or Alkyd Primer/Sealer & Vapor Barrier.
 - 1) PPG : 17-21 Seal-Grip Acrylic Latex Wall Primer/Sealer
 - 2) Benjamin Moore: Moore's Wall-Grip 2
 - 3) Sherwin Williams: PrepRite PreWallcovering Primer B28W8980
 - 4) Behr: Premium Plus All-In-One Primer & Sealer 75
- F. Interior Plaster:
- 1. Latex Lusterless (Flat) Emulsion Finish: 2 coats.
 - a. Primer and Finish Coats: Latex Interior Flat Paint
 - 1) PPG: 6-70 Speedhide Latex Flat Wall Paint
 - 2) Benjamin Moore: Moorcraft Super Spec Latex Flat 275
 - 3) Sherwin Williams: ProMar 200 Latex Flat Wall Paint B30W200 Series
 - 4) Behr: Behr Pro i300 Interior Flat 310

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Masonry (Clay and CMU): 12 percent.
 - 3. Wood: 15 percent.
 - 4. Gypsum Board: 12 percent.
 - 5. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
 - 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
 - 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of

shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear.
 - 1) Uninsulated metal piping.
 - 2) Uninsulated plastic piping.
 - 3) Pipe hangers and supports.
 - 4) Metal conduit.
 - 5) Plastic conduit.
 - 6) Tanks that do not have factory-applied final finishes.
 - 7) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material, and internal surfaces of metal

ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - 1) Uninsulated metal piping.
 - 2) Uninsulated plastic piping.
 - 3) Pipe hangers and supports.
 - 4) Metal conduit.
 - 5) Plastic conduit.
 - 6) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 7) Other items as directed by Architect.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION

10 14 00

SIGNAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior marquee signs.
 - 2. Exterior handicapped parking signs and sign supports
 - 3. Interior painted photo polymer panel signs.
 - 4. Vinyl die cut signs.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Division 10 Section "Directories" for building directories.
 - 2. Division 14 Section "Hydraulic Elevators" for code-required elevator signage.
 - 3. Division 23 Section "Mechanical Identification" for labels, tags, and nameplates for mechanical equipment.
 - 4. Division 26 Sections for electrical service and connections for illuminated signs.
 - 5. Division 26 Section "Electrical Identification" for labels, tags, and nameplates for electrical equipment.
 - 6. Division 26 Section "Interior Lighting" for illuminated Exit signs.

1.4 DEFINITIONS

- A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for signs.
 - 1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 2. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available for the following:
 - 1. Aluminum.
 - 2. Acrylic sheet.

3. Die-cut vinyl characters and graphic symbols. Include representative samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:
 1. Plaque Casting: 6 inches (150 mm) square including border.
 2. Dimensional Characters: Full-size Samples of each type of dimensional character (letter, number, and graphic element).
 3. Acrylic Sheet: 8 by 10 inches (200 by 250 mm) for each color required.
 4. Panel Signs: Not less than 12 inches (305 mm) square including border.
 5. Vinyl die cut signs.
 6. Accessories: Manufacturer's full-size unit.
- E. Sign Schedule: Use same designations indicated on Drawings.
- F. Qualification Data: For Installer and fabricator.
- G. Maintenance Data: For signs to include in maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful inservice performance.
- C. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.
- D. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

- A. Coordinate placement of anchorage devices with templates for installing signs.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Deterioration of metal and polymer finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image colors and sign lamination.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Aluminum Sheet and Plate: ASTM B 209(ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
- B. Aluminum Extrusions: ASTM B 221(ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.
- C. Cast Acrylic Sheet: Provide clear cast (not extruded or continuous cast) methacrylate plastic sheet with a minimum flexural strength of 16,000 psi, ASTM D 790, minimum allowable continuous service temperature of 180-degrees F (82-degrees C); in sizes and thicknesses indicated; "Plexiglas" by Rohm and Haas, Acrylite GP by Cyro Industries, or "Lucite L" by General Electric.
- D. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
- E. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils(0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.
- F. Polyurethane Enamel: Provide polyurethane enamel consisting of ultra-violet inhibitors which are lightfast, weather, abrasion and wear resistant. Provide one of the following:
 1. Chemglaze, Hughson Chemical Division, Lord Corp.
 2. Imron, DuPont de Nemours & Co.
- G. Steel Pipe: ASTM A53, Type EF, or G at fabricators option, Grade A, black finish, unless otherwise shown as galvanized standard weight, (Schedule 40).

2.2 MARQUEE SIGNS

- A. Basis of Design Product: Subject to compliance with requirements, provide Model AF-3500 (76- foot minimum viewing distance) Monochrome Outdoor Full-Matrix Display manufactured by Daktronics, Inc., Brookings, SD; (Tel) 888-325-7446, or Architect approved equal:
- B. Technical Specifications: Provide exterior marquee signs as follows:
 1. Cabinet Enclosure Material: Aluminum sheet, Minimum 0.060 thick.
 2. Mounting: Concealed studs, noncorroding for substrates encountered.
 3. Color: As selected by Architect from manufacturer's full range.
 4. Character Height: (*) 9 or 10 inches (seven (7) pixel font) (*) with min. 3 lines of text.
 5. Pixel Pitch: 0.78 inch center to center.
 6. Resolution: (*) 34mm, 82 pixels per square foot.
 7. Color Capability: (*) 4,096 shades of red and amber (*) available. Confirm red or amber with HISD Project Manager.
 8. LEDs per Pixel: One (1) red (*) or two (2) amber.
 9. Estimated LED Lifetime: 100,000+ hours.
 10. Horizontal Viewing Angle: 90 degrees (45 degrees left and right)
 11. Vertical Viewing Angle: 40 degrees (20 degrees up and down)
 12. Contrast Enhancement: (*) Non-reflective black louvers.

13. Cabinet Configuration: Front access, ventilated single cabinet.
14. Graphic Capability: Text, graphics, logos, basic animation, multiple font styles and sizes.
15. Control Software: Venus® 1500 (*) Version 3.X software.
16. Power: 120/240 VAC single phase.
17. Display Dimming: 64 levels (automatic or manual control)
18. Communication Options: Variety of direct connect or wireless options available.
19. Matrix Size: 48 x 112
20. Cabinet Size: (*) 3'-10" high x 7'-10" wide x 8" deep.
21. Weight: 300 lbs. per single face.
22. Minimum viewing distance: 76'
23. Maximum Watts per Face (Red): 760
24. Number: One double-sided marquee signs.
25. Location: As shown on drawings.
26. Plaque Schedule: Refer to Drawing for size, details, message, finishes and locations required.

2.3 INTERIOR PANEL SIGNS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. ACE Sign Systems, Inc.
 2. Advance Corporation; Braille-Tac Division.
 3. Allen Industries Architectural Signage
 4. Allenite Signs; Allen Marking Products, Inc.
 5. APCO Graphics, Inc.
 6. ASI-Modulex, Inc.
 7. Best Sign Systems Inc.
 8. Bunting Graphics, Inc.
 9. Fossil Industries, Inc.
 10. Gemini Incorporated.
 11. Grimco, Inc.
 12. Innerface Sign Systems, Inc.
 13. InPro Corporation
 14. Matthews International Corporation; Bronze Division.
 15. Mills Manufacturing Company.
 16. Mohawk Sign Systems.
 17. Nelson-Harkins Industries.
 18. Seton Identification Products.
 19. Signature Signs, Incorporated.
 20. Supersine Company (The)
- B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch(1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
 1. Etched Photo Polymer Panel Signs: Provide photo polymer plaques with Helvetica Medium 5/8-inch high text, 4-inch high symbols and Grade 2 Braille, in sizes, arrangements and colors indicated. Provide panel signs with raised copy, pictorial symbols and Braille characters raised at least 1/32-inch above panel surface and complying with the requirements indicated and with the Americans with Disabilities Act of 1990, with amendments.
 2. Edge Condition: Square cut.
 3. Corner Condition: Round to radius indicated.
 4. Mounting: Unframed.
 - a. Wall mounted with two-face tape and adhesive.

5. Custom Paint Colors: Match Pantone color matching system.
6. Color: As selected by Architect from manufacturer's full range.
7. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.

2.4 EXTERIOR HANDICAPPED PARKING SIGNS AND VAN ACCESSIBLE SIGNS

- A. Basis of Design Product and Manufacturer: Provide Best Sign Systems, Montrose, CO, (Tel) 800-235-2378, Model SS01 "Reserved Parking with Handicapped Symbol" sign, size 12" x 18", and Model SS52 "Van Accessible" sign, size 12" x 6", each fabricated from minimum 0.042" (1.0 mm) thick bonderized steel with white baked enamel background and silk screened blue enamel with white symbol, or Bradley B-959 18 x 12 94175 with B-959 6 x 12 91387 distributed by Bauer Visual Graphics, Inc., Pasadena, TX (Tel) 713-473-5241, or equivalent approved. Provide complete with 2-3/8" OD x 10' long galvanized steel posts and brackets for mounting.
- B. Schedule: Refer to Drawings for sign types and locations required.

2.5 INTERIOR VINYL DIE-CUT FILM

- A. Provide 1-inch high, upper case, Helvetica Medium vinyl die-cut letters fabricated from, opaque non-reflective vinyl film, 0.0035-inch minimum thickness, with pressure sensitive adhesive backing, suitable for exterior and interior applications as follows.
- B. Interior Vinyl Die Cut Film Schedule: Refer to Drawing for size, details, message, finishes and locations required.

2.6 ACCESSORIES

- A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.
- B. Adhesives and Tapes: Provide General Electric GE 1200 sealant, translucent SCS 1201 or equivalent translucent silicone sealant accepted by Architect. Provide 1/16-inch thick foam tape for temporary support of sign units.

2.7 FABRICATION

- A. General: Provide manufacturer's standard signs of configurations indicated.
 1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
 2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
 3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
 4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for

recommendations for applying and designating finishes.

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

- A. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - 1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils(0.04 mm), medium gloss.

2.10 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
- B. Factory Priming for Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
 - 1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromatefree, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- C. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils(0.05 mm).

2.11 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Verify that items, including anchor inserts are sized and located to accommodate signs.
- C. Examine supporting members to ensure that surfaces are at elevations indicated or required

to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Confirm that substrate finishes have been completed and cured sufficiently to receive sign materials.
- B. Confirm that substrates to receive signs are clean, free of deleterious substances that would detract from the neat appearance of high quality sign work, or that would interfere with the durable installation of sign work.
- C. Do not proceed with installation of sign work until unacceptable conditions have been corrected and substrates are ready to receive sign work.

3.3 INSTALLATION

- A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
 - 1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
- B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
 - 1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
 - 2. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
 - 3. Signs Mounted on Glass: Provide matching opaque plate on opposite side of glass to conceal mounting materials.
- C. Marquee Sign: Mount plaques using standard fastening methods to comply with manufacturer's written instructions for type of wall surface indicated.
 - 1. Concealed Mounting: Mount plaques by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement.

3.4 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION

10 21 00

TOILET PARTITIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes furnishing and installing the following:
 - 1. Floor supported overhead braced solid phenolic plastic toilet compartments and wall mounted screens.
 - 2. Heavy-duty institutional stainless steel hardware.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 06 10 00 – Rough Carpentry: Wood blocking.
 - 2. Section 09 21 16 – Gypsum Drywall Assemblies.
 - 3. Section 09 30 00 – Tiling.
 - 4. Section 10 28 13 – Toilet Accessories.

1.4 SUBMITTALS

- A. Product Data: Submit product data for each type of compartment and screen required, schedule of types, finishes, sizes and locations, color charts and installation and maintenance instructions. Indicate accessories that are to be furnished with each unit.
- B. Shop Drawings: Submit shop drawings for compartment and screen units that are drawn to scale and indicating size and arrangement of units, mounting details, and relationship to supporting and adjacent related work of other Sections.
- C. Samples: Submit samples of solid plastic finishes, approximately 4" x 4" in size. Review of samples will be for color and texture only. Submit samples of each type of hardware, trim, and accessory.

1.5 QUALITY ASSURANCE

- A. Material Quality Assurance: Obtain solid phenolic plastic only from a source with sufficient capacity of consistent color range and texture required for this Project. Solid phenolic plastic shall match approved sample on file in the Architect's office.
- B. Qualifications of Fabricator: Only a firm that has had a minimum of 5 years successful experience in the design and fabrication of solid phenolic plastic compartment work similar to work required for this Project will be acceptable. Fabricator must have sufficient production capacity to design, fabricate, transport and deliver required solid phenolic plastic compartment work, anchorage and support work without causing delay in the Work. Fabricate solid phenolic plastic compartment work only at a plant engaged in producing similar units.

- C. Dimension Coordination: Coordinate and verify by measurement at the Project Site, dimensions affecting solid phenolic plastic compartments and related work. Submit written notification of field dimensions and conditions that vary from requirements indicated on the Drawings, approved shop drawings, in conflict with ADA and TAS requirements, or are detrimental to proper and timely installation of related work. Where conflicts occur, obtain determination from Architect prior to fabrication of solid phenolic plastic compartment and screen work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect stone during storage and construction against moisture, soiling, staining, and physical damage.
- B. Handle solid phenolic plastic material to prevent chipping, breakage, soiling, or other damage. Lift with wide-belt type slings wherever possible; do not use wire rope or ropes containing tar or other substances that might cause staining.
- C. Store materials on wood skids or pallets; distribute weight evenly and to prevent breakage or warping of components. Protect stored compartments from weather with waterproof, nonstaining covers or enclosures, but allow air to circulate around packaging.

1.7 JOB CONDITIONS

- A. Installer must review installation procedures and coordination with other work, with Contractor, and other contractors and subcontractors whose work will be affected by compartment work.

1.8 WARRANTY

- A. Furnish 10 year limited warranty for panels, doors, and stiles against breakage, corrosion, delamination, and defects in factory workmanship.
- B. Furnish one-year guarantee against defects in material and workmanship for stainless steel door hardware and mounting brackets.

PART 2 PRODUCTS

2.1 PRODUCT AND MANUFACTURER

- A. Subject to compliance with requirements, provide "1182.67 Duraline Series" floor supported – overhead braced compartments" and "1185 Duraline Series" wall mounted urinal screen units produced by Bobrick Washroom Equipment, or equivalent by Sanymetal, Accurate Partitions, Global Steel Products, Ampco, or Tex Lam Mfg., Inc.

2.2 COMPONENTS / MATERIALS

- A. Stiles, Panels, Doors, and Screens:
 - 1. Solid phenolic material with high-pressure matte finish melamine surfaces fused to core. Edges shall be black. Solid phenolic material shall meet National Fire Protection Association Class A, Uniform Building Code Class I, ASTM E-84 Fire Resistance Standards; flame spread 20, smoke density 95. Brown edges shall not be acceptable. Color and pattern as selected by Architect from full range of available standard colors.
 - 2. Finish Thickness:
 - a. Stiles and doors shall be 3/4-inch (19-mm) thick.
 - b. Panels and benches shall be 1/2-inch (13-mm) thick.

- B. Hardware, General:
 - 1. All hardware to be 18-8, type 304 stainless steel with satin finish.
 - 2. All hardware shall be concealed inside compartments with the exception of outswinging doors.
 - 3. Hardware of chrome plated "Zamac" is unacceptable.
- C. Latch:
 - 1. Sliding door latch shall be 16-gauge (1.6mm).
 - 2. Sliding door latch shall require less than 5-lb force to operate. Twisting latch operation will not be acceptable.
 - 3. Latch track shall be attached to door by theft resistant one-way stainless steel machine screws into factory installed metal inserts. Fasteners secured directly into the core are not acceptable.
 - 4. Latch handle shall have rubber bumper to act as a doorstop.
 - 5. Latch shall allow door to be lifted over 11-gauge (3-mm) keeper for emergency access.
 - 6. Metal to metal connection shall withstand a direct pull of over 1000-lbs per screw.
- D. Hinges:
 - 1. Continuous stainless steel hinges shall be installed on the interior side of each door for the full height of the door. Provide wrap around hinge design where doors are required to swing out. No integral hinges are permitted.
 - 2. Hinges shall be attached to door and stile by theft resistant one-way stainless steel machine screws into factory installed metal inserts. Fasteners secured directly into the core are not acceptable.
 - 3. Metal to metal connection shall withstand a direct pull of over 1000-lbs per screw.
- E. Coat Hook: stainless steel coat hook shall project no more than 1-1/8-inch (29-mm) from face of door and shall be secured by theft resistant one-way stainless steel screws.
- F. Mounting Brackets: Stainless steel mounting brackets shall be mounted inside compartment. Mounting brackets exposed on the exterior of the compartment will not be acceptable. Wall mounted urinal screen brackets shall be 11-gauge (3mm) double thickness.
- G. Leveling Device: 3/8" x 1" (10 mm x 25 mm) steel bar shall be chromate treated and double zinc plated; bolted to base of solid phenolic stile.
- H. Stile Shoe: One piece, 4-inch (102-mm) high, type 304, 22-gauge (0.8 mm) stainless steel with satin finish. Top shall have 90° return to stile.
- I. Headrail (Overhead braced): Extruded anodized aluminum with satin finish.

2.3 FABRICATION

- A. Complete fabrication, assembly, finish hardware application, and other work before shipment to the Project Site to maximum extent possible.
- B. Take field measurements for work required to be fitted to other construction.
- C. Fabricate each pilaster, divider, end, door, and screen panel from one piece of solid phenolic plastic only. Bevel edges 15° from edge surface.

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify that concealed blocking and substrates are properly prepared to receive compartments and screens. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Locate units and accessories where shown or scheduled, using mounting methods of type described and in compliance with manufacturer's instructions.

3.2 INSTALLATION

- A. Comply with manufacturer's instructions and mounting methods.
- B. Layout and install the work level, plumb and at height indicated and with clearances of not more than 1/2" between pilasters and partitions and not more than 1" at walls, free of scratches, dents, nicks, discolorations, and other defects in materials or workmanship.

3.3 CLEANING AND PROTECTION

- A. At completion of installation, promptly clean soiled surfaces in accordance with manufacturer's instructions.
- B. Protect units from damage until acceptance by Owner.

END OF SECTION

10 28 00

TOILET ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes furnishing and installing toilet accessories at the locations indicated.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 09 21 16 – Gypsum Board Assemblies.
 - 2. Section 09 30 00 – Tiling.
 - 3. Section 09 90 00 – Painting.
 - 4. Section 10 21 00 – Toilet Partitions.

1.4 SUBMITTALS

- A. Product Data: Submit product data for each type of unit required.
- B. Shop Drawings: Submit shop drawings for each type of unit required, including details of construction, finishes, fasteners, sizes and locations required.
 - 1. Show mounting locations and mounting heights.
 - 2. Show and relationship to framing, blocking, nailers and other related work.

1.5 PROJECT CONDITIONS

- A. Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting.
- B. Coordinate fabrication schedule with construction progress to avoid delay.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Refer to toilet accessory schedule in drawings for basis of design manufacturers and products. Subject to compliance with the Design/Performance and other requirements, equivalent systems by other manufacturers will be acceptable as approved by the architect.
- B. Provide toilet accessories with brushed finish stainless steel except as noted.
- C. Coordinate accessory keying and other requirements with Owner's Representative.
 - 1. Include coordination of Owner Furnished items.

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify that substrates, rough openings, and blocking are properly prepared to receive accessory units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Layout and securely install accessories and cabinets to supporting structure at locations indicated, level, plumb, at proper heights, and at margins indicated.
- B. Complete installation free of scratches, dents, nicks, discolorations, and other defects in materials or workmanship that cause accessory work to become unserviceable or objectionable in appearance.

3.3 CLEANING AND PROTECTION

- A. At completion of the installation, remove protective coverings and clean soiled accessory unit surfaces in accordance with the manufacturer's instructions.
- B. Protect units from damage until acceptance by Owner.

END OF SECTION

10 44 00

FIRE EXTINGUISHERS AND CABINETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes furnishing and installing portable fire extinguishers and fire extinguisher cabinets at the locations indicated.
- B. Related Sections:
 - 1. Division 04 Section – Unit Masonry.
 - 2. Division 09 Section – Gypsum Board Systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. Fire-Protection Cabinets: Include door hardware, cabinet type, trim style, panel style, and details of installation.
- B. Samples: For each exposed cabinet finish.
- C. Maintenance data.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
- C. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

- A. Apply vinyl lettering on field-painted fire-protection cabinets after painting is complete.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
 - 1. Sheet: ASTM B 209.
 - 2. Extruded Shapes: ASTM B 221.
- C. Stainless-Steel Sheet: ASTM A 666, Type 304.
- D. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3-mm thick, Class 1 (clear).

2.2 PORTABLE FIRE EXTINGUISHERS

- A. Available Manufacturers:
 - 1. Ansul Incorporated.
 - 2. JL Industries, Inc.
 - 3. Kidde Fyrnetics.
 - 4. Larsen's Manufacturing Company.
 - 5. Potter Roemer; Div. of Smith Industries, Inc.
- B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet indicated.
 - 1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.
- C. Multipurpose Dry-Chemical Type in Steel Container (Type FE-1): UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
- D. Multipurpose Dry-Chemical Type in Steel Container (Type FE-2): UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 FIRE-PROTECTION CABINET (FEC-1)

- A. Basis-of-Design Product: Provide fire extinguisher cabinets where indicated, of the following types and suitable size for housing fire extinguishers of types and capacities indicated. The following are the type and sizes of cabinets required for this Project. Equivalent units produced by J. L. Industries, Ansul Fire Protection, or Potter-Roemer, Inc. will be acceptable as approved:
 - 1. Manufacturer's standard 18 gage enameled steel flat-trim, semi-recessed box and solid flush door; Larsen's Model No. FS-SS2409-R4, 24" H x 9-1/2" W x 6" D, with 5/16" flat trim, and black die-cut vinyl "FIRE EXTINGUISHER" lettering vertical on door.
- B. Cabinet Construction: Fire-rated.
- C. Maximum Projection from Face of Wall to outermost portion of Fire Protection Cabinet: 4"

2.4 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth.
 - 1. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick, fire-barrier material. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2-inch thick.
 - 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Examine roughing-in for cabinets to verify actual locations of piping connections before cabinet installation.
- B. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.
- C. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.
- D. Prepare recesses for fire-protection cabinets as required by type and size of cabinet and trim style.
- E. Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- F. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fireprotection cabinets.
 - 2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- G. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
- H. Identification: Apply vinyl lettering at locations indicated.
- I. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- J. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair.

3.2 CLEANING AND PROTECTION

- A. At completion of the installation, remove protective coverings and clean soiled accessory unit surfaces in accordance with the manufacturer's instructions.

- B. Protect units from damage until acceptance by Owner.
END OF SECTION

11 31 00

RESIDENTIAL APPLIANCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes residential appliances at locations scheduled on the Drawings.
- B. Related Sections:
 - 1. Section 06 10 00 – Rough Carpentry for built-in wood blocking.
 - 2. Section 06 40 00 – Architectural Woodwork.
 - 3. Section 07 92 00 – Joint Sealants.
 - 4. Section 09 21 16 – Gypsum Board Assemblies.
 - 5. Section 09 65 00 – Resilient Flooring.
 - 6. Division 22 Sections for plumbing system rough-in.
 - 7. Division 23 Sections for HVAC system rough-in.
 - 8. Division 26 Sections for electrical system rough-in.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, dimensions, furnished accessories, and finishes for each appliance.
- B. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.
- C. Product Schedule: For appliances. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of appliance, from manufacturer.
- C. Field quality-control reports.
- D. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintains, within 40 miles of Project site, a service center

capable of providing training, parts, and emergency maintenance repairs.

- B. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.
- C. Source Limitations: Obtain residential appliances from single source and each type of residential appliance from single manufacturer.
- D. Regulatory Requirements: Comply with the following:
 - 1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.
- E. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with Texas Accessibility Standards and the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
- F. Preinstallation Conference: Conduct conference at Project site.

1.7 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.
- B. Refrigerator/Freezer/Icemaker, Sealed System: Limited warranty including parts and labor for first year and parts thereafter for on-site service on the product and for the following:
 - 1. Sealed Refrigeration System: Five years from date of Substantial Completion.
 - 2. Other Components: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 RESIDENTIAL APPLIANCES

- A. Basis-of-Design Products:
 - 1. Refrigerator, General Electric GTE21GSHSS, stainless steel, top freezer, 21.2cu.ft., 33"x66.75"x34", ADA Compliant.

2.2 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.

- C. Examine walls, ceilings, and roofs for suitable conditions where overhead exhaust hoods will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Comply with manufacturer's written instructions.
- B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- D. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.
- E. Utilities: Comply with plumbing and electrical requirements.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After installation, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
- C. An appliance will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION

12 21 00

HORIZONTAL LOUVER BLINDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing window shades at exterior window vision lights indicated.
 - 1. Section includes furnishing and installing manual, horizontal louver blinds with aluminum slats at all exterior window vision lights within glazing system enframement, surface mounted on head, and extending to sill.
 - 2. Work excludes vision lights at all exterior doors and sidelights.

1.3 RELATED WORK

- A. Related Work of Other Sections:
 - 1. Section 08 41 00 – Entrances and Storefront

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, details of installation, operational clearances, wiring diagrams, and relationship to adjoining Work.
 - 1. Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 2. Provide coordination drawings drawn to scale and coordinating penetrations and ceiling-mounted items.
- C. Samples: For each exposed finish and for each color required.
- D. Window Treatment Schedule: Use same room designations indicated on Drawings.
- E. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products A qualified installer, approved by manufacturer to install manufacturer's products.
- B. Horizontal Louver Blinds Fire-Test-Response Characteristics: Provide products passing flameresistance testing according to NFPA 701 by a testing agency acceptable to authorities having jurisdiction.
- C. Corded Window Covering Product Standard: Comply with WCMA A 100.1.

PART 2 PRODUCTS

2.1 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Hunter Douglas Contract.
 - 2. Levolor Contract; a Newell Rubbermaid company.
 - 3. Springs Window Fashions; SWFcontract.

- B. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.
 - 1. Width: 1 inch.
 - 2. Thickness: Not less than 0.008 inch.
 - 3. Spacing: Manufacturer's standard.
 - 4. Finish: Ionized antistatic, dust-repellent, baked polyester finish.

- C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.
 - 1. Capacity: One blind per headrail unless otherwise indicated.
 - 2. Ends: Manufacturer's standard.
 - 3. Manual Lift Mechanism:
 - a. Lift-Cord Lock: Variable; stops lift cord at user-selected position within blind full operating range.
 - b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.
 - 4. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
 - a. Tilt: Full.
 - b. Operator: Corrosion-resistant steel rod.
 - c. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.
 - 5. Manual Lift-Operator and Tilt-Operator Lengths: Manufacturer's standard.
 - 6. Manual Lift-Operator and Tilt-Operator Locations: Manufacturer's standard unless otherwise indicated.

- D. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.
 - 1. Type: Manufacturer's standard. FABRICATION

- E. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.
 - 1. Type: Braided cord.

- F. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.
 - 1. Type: Overhead.
 - 2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by blind manufacturer for weight and size of blind.

- G. Colors, Textures, Patterns, and Gloss:
 - 1. Slats: As selected by Architect from manufacturer's full range.
 - 2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

2.2 HORIZONTAL LOUVER BLIND FABRICATION

- A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch. Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch, plus or minus 1/8 inch.
 - 2. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 - 1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
- D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind placement indicated.
- E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
- F. Color-Coated Finish:
 - 1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Locate so exterior slat edges are not closer than 1 inch from interior faces of glass and not closer than 1/2 inch from interior faces of glazing frames through full operating ranges of blinds.
 - 2. Install mounting and intermediate brackets to prevent deflection of headrails.
 - 3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

- A. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer and that ensures that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

END OF SECTION

21 00 00

GENERAL REQUIREMENTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Basic Fire Protection Requirements specifically applicable to Division 21 sections, in addition to Division 01 - General Requirements.

1.2 RELATED DOCUMENTS

- A. Basic and supplemental requirements common to Fire Protection.
- B. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the specifications apply to the work specified in this section.
- C. All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.3 GENERAL

- A. The Contractor shall execute all work herein after specified or indicated on accompanying drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.
- B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation
- C. The Fire Protection Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, above suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed or where no ceilings exist. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted. All work shall be NFPA compliant and compliant with Insurance Underwriter requirements and guidelines.
- D. When the Fire Protection drawings do not give exact details as to the elevation of pipe the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping is generally intended to be installed true and square to the building construction, The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas, unless there is no ceiling.

1.4 DEFINITIONS

- A. These definitions are included to clarify the direction and intention of these Specifications. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.
1. Concealed / Exposed: Concealed areas are those that cannot be seen by the building occupants. Exposed areas are all areas that are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.
 2. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements that are included in project. Basic contract definitions are included in the General Conditions.
 3. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.
 4. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.
 5. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.
 6. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."
 7. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."
 8. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
 9. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.5 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

- A. General: Refer to Division 01 for construction phasing and time increments.
- B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If city or privately owned utility piping or

electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

- C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to city controlled services. If inspections by city personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.
- D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.
- E. Fire hydrant flow test shall be witnessed by a representative of Fort Bend County W.C. & I.D. No. 2 (Phone No: 281-499-1031).

1.6 CONTRACT DRAWINGS

- A. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
- B. The interrelation of the specifications, the Drawings, and the Schedules are as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions and details, and the Schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.
- C. Should the drawings or specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.7 ALLOWANCES

- A. Cash Allowance: Refer to Division 01 of the Construction Documents for information and requirements.

1.8 SUBMITTALS

- A. Refer to Division 01, UGC, and supplemental UGCs for specification requirements pertaining to timeliness of submission and review, quantity, and format. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.
- B. Proposed Products List: Include Products specified in the following sections:
 - 1. Section 21 05 29 – Fire Protection Supports and Sleeves
 - 2. Section 21 05 53 – Fire Protection Piping and Equipment Identification
 - 3. Section 21 08 00 – Fire Protection Systems Commissioning
 - 4. Section 21 10 00 – Water Based Fire Suppression Systems

5. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories clearly marked and/or highlighted, with non-applicable information or data clearly noted in a single submittal.

C. Mark dimensions and values in units to match those specified.

D. Submit fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

1.9 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of Contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment that will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these specifications have been met and samples shall be furnished when requested. All manufacturers' data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the drawings and/or specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the drawings and specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks' time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for

allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

- G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.
- H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.
- I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the specifications.
- J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.
- K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the shop drawings.
- L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.10 MATERIALS AND WORKMANSHIP

- A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.
- B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.11 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.12 REGULATORY REQUIREMENTS

- A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.
- B. National Fire Protection Association Standards (NFPA)
 - 1. NFPA No. 13, Sprinkler System, Installation, 2013 edition.
 - 2. NFPA No. 70, National Electrical Code, 2017 edition.
 - 3. NFPA No. 72D, Proprietary Signaling Systems, 2013 edition.
 - 4. NFPA No. 101, Life Safety Code, 2015 edition.
 - 5. NFPA No. 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants, current edition.
- C. American National Standards Institute (ANSI)
- D. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards
- E. American Water Works Association (AWWA): All current editions of applicable manuals and standards.
- F. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.
- G. International Building and Fire Codes, 2015 edition with City of Stafford, Texas amendments.
- H. City of Stafford, Texas Fire Department as may be applicable to construction on this site.
- I. Texas Occupational Safety Act: All applicable safety standards.
- J. Occupational Safety and Health Act (OSHA).
- K. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.
- L. Refer to Specification sections hereinafter bound for additional Codes and Standards.
- M. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

- N. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations

1.13 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

- A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.
- B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.
- C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.
- D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.
- E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot dip galvanized, mill galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.
- F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.
- G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.14 PROJECT/SITE CONDITIONS

1. Install Work in locations shown on drawings, unless prevented by Project conditions.
2. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other sections. Obtain permission of Owner before proceeding.

1.15 MANUFACTURER'S RECOMMENDATIONS

- A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, testing and piping of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer's directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.16 SPACE AND EQUIPMENT ARRANGEMENT

- A. The size of Fire Protection equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.
- B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.17 LARGE APPARATUS

- A. Any large piece of apparatus that is to be installed in any space in the building, and that is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.18 PROTECTION

- A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.
- B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.
- C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

1.19 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

- A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.20 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

- A. The Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.
- B. The electrical trades shall provide all interconnecting wiring for the installation of all power. The electrical trades shall provide all disconnect switches as required for proper operation, as indicated on the drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 21.
- C. Provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the electrical trades by the Contractor.

1.21 SUPERVISION

- A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)
- B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the drawings, the matter shall be referred to the A/E for ruling.

1.22 SITE OBSERVATION

- A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.23 INSTALLATION METHODS

- A. Where to Conceal: All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

- B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.
- C. Support: All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.
- D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.
- E. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All pipes run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.
 - 1. All piping not directly buried in the ground shall be considered as "interior piping."
 - 2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 5 working days or as agreed by the Project Manager.
 - 3. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid shall be complete and installed in accordance with contract requirements, including power to other powered items. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer and Owner's Construction Manager. Areas to be included and time of inspection shall be coordinated with the Construction Inspector.
 - 4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
 - 5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.24 RECORDS FOR OWNER

- A. The Contractor shall maintain a set of "blueprint" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.
- B. At contract completion, the Contractor shall provide an electronic file of the revised drawings. The Contractor shall transfer the information from the "blueprint" prints maintained as described above, and turn over this neatly marked set of reproducible drawings representing the "as installed" work to the Architect/Engineer for verification and subsequent transmittal to the

Owner. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information. These Drawings shall include as a minimum:

1. Addendum written Drawing changes.
2. Addendum supplementary Drawings.
3. Accurate, dimensioned locations of all underground utilities, services and systems.
4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
5. Change Order written Drawing changes.
6. Change Order supplementary Drawings.

C. Electronic Media

1. The Contractor shall submit three (3) compact discs containing all the Drawings in AutoCAD 2017 or 2018 format.

D. "As installed" plans shall bear a stamp, "stick-on decal" or lettered title block generally located in lower right hand corner of drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
2. Two (2) sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
3. Valve tag charts and diagrams specified herein.
4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
5. Copies of approved shop drawings.
6. Any and all other data and/or drawings required as submittals during construction.
7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.
7. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.25 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as new" condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the

operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

- E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.
- F. Special Note: No cutting, boring, or excavating that will weaken the structure shall be undertaken.

1.26 ROOF PENETRATIONS AND FLASHING

- A. Pipe, sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.27 EXCAVATION, TRENCHING AND BACKFILL

- A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):
 - 1. The subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the drawings and/or required for the installation of piping. All exterior lines shall be installed with a minimum cover of 24," unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe.
 - 2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the International Fire Code for the service intended and the size used. Bell holes for pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room to complete the pipe joint . Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to ensure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. Special pipe beds shall be provided as specified hereinafter.
 - 3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by workers especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6" below the trench depths specified. The over depth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the

- trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.
4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.
 5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.
 6. Excavate as required under the building in order that all piping, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.
 7. Trenches for water lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.
 8. All surplus materials removed in these trenching operations becomes the property of the Contractor, and shall be disposed of at the expense of the Contractor, at a legal disposal site, off of the campus.

B. Backfilling

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1-1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.
2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.
3. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.
4. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction

Inspector will give immediate instructions for the disposition of it. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.28 OPERATION PRIOR TO COMPLETION

- A. When any piece of Fire Protection equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.
- B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, properly adjust and complete all deficiency list items prior to being started, commissioned and before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.29 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

- A. Check inspections shall include fire sprinkler piping, equipment, overall fire protection system controls, and such other items hereinafter specified or specifically designated by the Architect/Engineer.
- B. Contractor shall fill out and submit a "Material and test certificate" in compliance with NFPA 13 – 10.10.0 AND receive fire marshal sign-off prior to 100% payment of underground portion of work.
- C. Contractor shall fill out and submit a "Material and test certificate" per NFPA 13 – 16.1 AND receive fire marshal sign-off prior to payment of 100% for above ground work.
- D. Third party inspections shall be completed prior to final payment.
- E. Contractor shall perform work as required to comply with third party inspections.

1.30 COOPERATION AND CLEANUP

- A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.31 CLEANING AND PAINTING

- A. All equipment and piping, etc., furnished and installed in exposed areas under Division 21 of these specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 21 work.

- B. All purchased equipment shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.
- C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metalwork shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.
- D. Color of finish painting shall be painted in accordance with The Stafford Municipal School District Standard Color Schedule for machinery spaces using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. Two (2) coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

ITEM	COLOR	"P and L" PAINT NUMBER
Fire Protection Equipment and Piping	Safety Red	R131R (Vibrant Red)

- 1. Note that the paint specified above is included for purposes of establishing a QUALITY THAT shall be used on this Project. The proposed paint shall be submitted, and alternatives will be considered using the submittal procedures specified in this document.
- E. Jacketing on insulation shall not be painted.
- F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.
- G. Scope of painting for Division 21 Work in areas other than those defined as "exposed" is as follows:
 - 1. All uncovered steel pipe, supports, exposed pipe and hanger rod threads, and hangers in underfloor spaces shall be cleaned and painted with two (2) coats of Tropical Paint Co. No. 77-black asphaltic emulsion. Galvanized steel and copper lines in these spaces shall not be painted.
 - 2. All canvas finishes including those underfloor and in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.
 - 3. All fire protection piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA.
 - 4. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting Specification or instruction, should a conflict in the Construction Documents exist.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

- B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.
- C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.
- D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.
- E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.
- F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.2 NAMEPLATES

- A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.
- B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters.
- C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.
- D. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.
 - 1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.3 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

- A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.
- B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.
- C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.
- D. Plates will not be required for piping where pipe sleeves extend 3/4-inch or more above finished floor.

2.4 ROOF PENETRATIONS AND FLASHING

- A. Pipe sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.
- B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.
- C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.
- D. Space Requirements:
 - 1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
 - 2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.
- E. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations, as shown on the drawings and stated in the specifications.
- C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.
- D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred

ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

- E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.
- F. Precedence of Materials:
 - 1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.
 - 2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":
 - a. Building lines
 - b. Structural members
 - c. Structural support frames supporting ceiling equipment
 - d. Soil and drain piping
 - e. Vent piping
 - f. Supply, return and outside air ductwork
 - g. Exhaust ductwork
 - h. Condensate piping
 - i. Fire protection piping
 - j. Domestic water (cold and hot, softened, treated)
 - k. Refrigerant piping
 - l. Electrical conduit
 - 3. Coordinate fire protection system with other trade systems as required to maintain system right-of-ways.

3.3 TESTING

- A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of Substantial Completion, whichever occurs first.
- B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean and properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.
- C. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association (NFPA), ASTM, etc. standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.
- D. Notify the Project Manager and the Architect/Engineer in writing at least five (5) calendar days or as agreed by the Project Manager prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.
- E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results and other pertinent data.

Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

- F. Maintain Log of Tests as hereinafter specified.
- G. See Specifications hereinafter for additional tests and requirements.
- H. Refer to Commissioning Specification Sections for additional Start-up, pre-functional and operational checkout, and for functional performance test procedures.

3.4 TRAINING

- A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled "Project Closeout Procedures."
- B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

END OF SECTION 21 00 00

21 05 29

FIRE PROTECTION HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Equipment supports.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. NFPA Compliance: Comply with NFPA 13 and NFPA 14.
- D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot-dip galvanized.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line, an Eaton business.
 - b. Flex-Strut Inc.
 - c. Unistrut; Part of Atkore International.
 - 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 4. Channels: Continuous slotted carbon-steel channel with inturred lips.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 8. Metallic Coating: Hot-dip galvanized.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Not allowed.

- B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - 2. Indoor Applications: Zinc-coated or stainless steel.
 - 3. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.7 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout, suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.
- D. Fastener System Installation:
 1. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099000 "Painting and Coating."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Comply with NFPA requirements.
- J. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. C-Clamps (MSS Type 23): For structural shapes.
 3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- K. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 210529

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FIRE PROTECTION PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

- A. Section 21 00 00 – General Requirements for Fire Suppression.
- B. Section 21 05 29 – Fire Protection Supports and Sleeves.

1.3 SECTION INCLUDES

- A. Nameplates
- B. Tags
- C. Pipe Markers

1.4 RELATED SECTIONS

- A. Section 09 91 00 – Painting: Identification painting.

1.5 REFERENCES

- A. ASME A13.1 – Scheme for the Identification of Piping Systems.
- B. IFC - International Fire Code, 2015 edition.
- C. NFPA 13 - Sprinkler System, Installation, 2013 edition.

1.6 SUBMITTALS

- A. Submit under provisions of Section 21 00 00.
- B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for fire suppression equipment, piping and valve identification.
 - 1. Equipment Label Schedule: Provide a schedule of all equipment to be labeled with the proposed content for each label.
 - 2. Access Panel and Door Markers: Provide a schedule of all panels and doors to be labeled with the proposed content for each label.
 - 3. Pipe Label Schedule: Provide a schedule of each piping systems indicating a proposed nomenclature and location of all pipe markers.
 - 4. Valve Chart and Schedule: Provide a proposed valve numbering scheme and schedule for each piping system. Tabulate valve number, room or space location, function, valve manufacturer's name and model number, piping system, system abbreviation as shown

on tag, normal-operating position (open, closed, or modulating), and variations for identification. Mark valves intended for emergency shut-off and similar special uses.

5. Warning Tags: Provide a schedule of all equipment to be labeled with the proposed content for each label.

- C. Product Data: Provide manufacturers' catalog literature for each product required, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

- D. Samples: Submit two (2) of each type of label, tag, etc., of the approximate size specified of implied in the Specification.

- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.7 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- B. Coordinate installation of identifying devices with locations of access panels and doors.

- C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 21 00 00.

- B. Record actual locations of tagged valves and update schedules accordingly.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five (5) years documented experience

- B. Installer Qualifications: Company specializing in performing Work of this section with minimum five (5) years documented experience.

- C. ASME Standards: Comply with ASME A13.1 for color scheme, lettering size, length of color field, and viewing angles of identification devices.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging with labels clearly identifying product name and manufacturer until ready for installation.

- B. Storage: Store materials in clean, dry area indoors until ready for installation.

- C. Handling: Protect materials and finish from damage during handling and installation.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fire pumps, etc., are to be clearly marked using engraved nameplates as specified. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner's Designated Representative.
- C. General: Provide manufacturer's standard products of categories and types required for each application specified. For each identification type, provide all products from same manufacturer with same text, style, color, shape, and other identification features.
 - 1. Provide nameplates with the unit number on all mechanical equipment.
 - 2. Access panel and door markers for standpipes, hose and fire extinguisher cabinets, fire and smoke dampers, etc.
 - 3. Provide pipe identification labels including direction-of-flow arrows and with service indicated. All labels shall have background colors matched with specific service designation.
 - 4. Provide valve tag numbers on all valves.
 - 5. Warning tags at motors and equipment controlled by automatic starters, etc.

2.2 MANUFACTURERS

- A. Equipment Tags, Valve Tags, and Markers:
 - 1. Marking Services, Inc.
 - 2. Seton, owned by Brady Corporation.
 - 3. Brady Corporation
 - 4. Graphic Products, Inc.
 - 5. Brimar Industries.
 - 6. Craftmark.

2.3 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness:
 - a. Indoors: Multilayer, multicolor, plastic labels for fire suppression piping and equipment engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - b. Outdoors: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate.
 - 2. Letter Color: White
 - 3. Background Color: Red
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 1 by 3 inches.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.
 - 7. Fasteners: Stainless-steel self-tapping screws.

- B. Label Content: Nomenclature on the label is to include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- D. All scheduled equipment shall be identified with an Equipment Tag.

2.4 ACCESS PANEL AND DOOR MARKERS

- A. Material and Thickness: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification.
- B. Letter Color: White
- C. Background Color: Red
- D. Fasteners: Self-tapping, stainless steel screws or contact-type, permanent adhesive.

2.5 VALVE CHART

- A. The Contractor shall prepare and install, in a suitable glazed anodized aluminum frame, typewritten valve charts giving the number, location, function and area or rooms served for each line valve installed under this contract.
- B. Each valve shall be numbered on these charts in accordance with the system of which it is a part of and its location.

2.6 VALVE TAGS

- A. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above.
- B. Valve tags shall conform to ANSI A13.1. Valve Tags (Indoors): Stamped or engraved with 1/4 inch letters for piping abbreviation and 1/2 inch numbers.
 - 1. Tag Material: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Background Color: Natural brass.
 - 3. Letter Color: Black.
 - 4. Tag Size: 1-1/2 inches, round.
 - 5. Fasteners: Brass S-Hooks and Jack Chain.
- C. Valve Tags (Outdoors):
 - 1. Material: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate, and having stainless steel grommet protected predrilled holes with for attachment hardware.
 - 2. Background Color: Red.
 - 3. Letter Color: White.
 - 4. Tag Size: Minimum 1-1/2 inches.

- 5. Fasteners: Stainless steel S-Hooks and stainless steel Jack Chain.

2.7 PIPE LABELS (INDOOR PIPING)

- A. Provide labels for above ground piping located indoors, and not exposed to sunlight or a harsh environment.
- B. Pipe labels shall pre-printed, color-coded, with lettering indicating service, and showing flow direction in conformance with ANSI A13.1 as indicated below.

Pipe Contents	Label Abbreviation	Label Colors (Background/Text)
Fire Suppression Water	FIRE	Red/White
Wet Sprinklers	WET FIRE	Red/White

- C. Lettering shall be sub-surface printed and protected from direct contact by a layer of plastic. Markers with surface printed lettering will not be accepted.
- D. Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
- E. Plastic Labels for Pipe O.D. less than 8 inches: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around full circumference pipe or pipe covering and to attach to pipe without fasteners or adhesive in contact with the pipe surface.
- F. Pipe Labels for Pipe O.D. 8 inches and Over: Strap-on, semi rigid plastic to cover partial circumference of pipe and to attach to pipe with nylon ties.
- G. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.
- H. Pipe markers and arrow markers also shall be provided for all piping systems.

2.8 PIPE LABELS (OUTDOOR PIPING)

- A. Provide labels for above ground piping located outside, and exposed to sunlight or a harsh environment, the following product is specified.
- B. Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
- C. Pipe markers shall be constructed of printed 5 mil polyester and top laminated with ultraviolet and chemical resistant plastic film that is engineered to provide maximum durability of the printed legend. Markers shall be pre-coiled to wrap entirely around the circumference of pipe up to 10 inch outside diameter, and self-sealed with a strip of clear ultraviolet and chemical resistant plastic film. Coiled markers shall seal to themselves, and not the pipe surface.

- D. Pipe Labels for pipe O.D. up to 10 inches: Shall be labeled with a single piece, pre-printed marker that wraps entirely around the circumference of the pipe, overlaps and seals to itself rather than adhere to the pipe surface.
- E. Pipe Labels for pipe O.D. 10 inches and greater: Shall be constructed of printed 5 mil polyester and top laminated with clear ultraviolet and chemical resistant plastic film that is pre-applied to an acrylic-faced, co-extruded ABS plastic carrier. Carrier shall have pre-formed legs running the entire length of the part to ensure marker remains straight and aligned with pipe. Flow direction shall be identified by application of a separate arrow label of same construction. Carriers shall be affixed to piping by means of two (2) stainless steel straps that wrap entirely around the circumference of the pipe.
- F. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.9 CEILING TACKS

- A. Description: Steel with 3/4 inch or 7/8" diameter color coded head.
- B. Color code: Red.

2.10 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

- A. Description: 3/4" x variable length vinyl label, 3.0 mil self-adhesive vinyl similar to Graphic Products, Inc. DuraLabel Pro™. Label color shall be black text on a white background.
- B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.
- C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

2.11 WARNING SIGNS AND LABELS

- D. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- E. Letter Color: White.
- F. Background Color: Red.
- G. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- H. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- I. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.
- J. Fasteners: Stainless-steel self-tapping screws.
- K. Label Content: Include caution and warning information, plus emergency notification instructions.

2.12 WARNING TAGS

- A. Material: Reprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
- B. Size: 3 by 5-1/4 inches minimum.
- C. Fasteners: Brass grommet and wire.
- D. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
- E. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Install identifying devices after completion of coverings and painting.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.
- B. For pipe markers that are pre-coiled or strap-on type and do not adhere directly to the piping, no surface preparation is necessary.

3.3 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.

3.4 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of fire suppression equipment.
- B. Locate equipment labels where accessible and visible.

3.5 ACCESS PANEL AND DOOR MARKERS INSTALLATION

- A. Install or permanently fasten markers on access panels and door for fire suppression equipment.
- B. Locate labels where accessible and visible.

3.6 VALVE TAGS INSTALLATION

- A. Contractor(s) shall provide and install valve tags on all valves installed within this Project, except check valves and valves within factory-fabricated equipment units..
- L. List tagged valves in a valve schedule.

3.7 PIPE LABEL INSTALLATION

- A. Piping runs throughout the Project including those above lift-out ceilings, underfloor and those exposed to view when access doors or access panels are opened shall be identified by means of pipe markers. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements. In addition to pipe markers, arrow markers shall be used to indicate direction of flow.
- B. As a minimum, locate pipe markers as follows:
 - 1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.
 - 2. Every 20 feet in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.
 - 3. At each branch or riser takeoff on piping systems.
 - 4. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.
 - 5. At access doors, manholes and similar access points that permit view of concealed piping.
 - 6. Near major equipment items and other points of origination and termination.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.
- D. Provide a double-ended arrow marker when flow can be in either or both directions.
- E. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer's instructions.
- F. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.
- G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

3.8 WARNING TAGS INSTALLATION

- M. Write required message on, and attach warning tags to, equipment and other items where required.

3.9 CEILING TACKS INSTALLATION

- A. Mark location of equipment or valves located above ceilings with identifying "buttons" to help in identification for maintenance.

3.10 CEILING GRID TAGS INSTALLATION

- A. Provide ceiling grid tags to locate valves or other concealed equipment above T-bar type panel ceilings. Locate in corner of grid closest to equipment.

3.11 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 21 05 53

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WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

- A. The Contractor shall provide all components required for the complete installation of automatic sprinkler systems as hereinafter specified and indicated on the Drawings.
- B. System Layout: The fire sprinkler areas, piping, head locations, etc. as indicated is only for Contractor's reference as to areas to be protected and possible piping routes. If header or manifold sizes are given in the drawings, then the sizes given shall be the minimum sizes installed. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer. Modifications to head spacing, pipe routes, etc. shall be closely coordinated with the work of all other trades. The Fire Sprinkler Subcontractor shall be responsible for the design and installation of the fire sprinkler system as described herein and on the project drawings. The piping of the system shall be sized used the "hydraulic" method, as included in NFPA Standard No. 13. Piping sized using the "schedule" method is unacceptable.

1.2 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

- A. Section 21 00 00 – General Requirements for Fire Suppression
- B. Section 21 05 29 – Fire Protection Supports and Sleeves
- C. Section 21 05 53 – Fire Protection Piping and Equipment Identification

1.3 SECTION INCLUDES

- A. Pipe, fittings, valves, and connections for sprinkler system.

1.4 RELATED SECTIONS

- A. Section 31 23 16.13 – Trenching
- B. Section 09 91 00 - Painting

1.5 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.
- F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.
- G. ANSI/ASME B16.25 - Buttwelding Ends.
- H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- I. ANSI/ASME Boiler and Pressure Vessel Code (BPVC), Sec IX - Welding and Brazing Qualifications.
- J. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- K. ANSI/ASTM A47 - Malleable Iron Castings.
- L. ANSI/ASTM B32 - Solder Metal.
- M. ANSI/AWS A5.8 - Brazing Filler Metal.
- N. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.
- O. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
- P. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- Q. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated (Galvanized) Welded and Seamless, for Ordinary Uses.
- R. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- S. ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- T. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

- U. IFC - International Fire Code, 2015 edition with City of Stafford, Texas amendments.
- V. NFPA 13 - Installation of Sprinkler Systems, 2013 edition.
- W. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances
- X. NFPA 51B - Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.
- Y. UL - Fire Protection Equipment Directory.
- Z. City of Stafford, Texas, Fire Department Standards.
- AA. State of Texas, State Fire Marshal Rules.
- BB. All hose threads, coupling types, etc., utilized in the fire protection systems shall conform to the standards and requirements of the City of Stafford, Texas Fire Department.

1.6 SUBMITTALS

- A. Submit under provisions of Section 21 00 00.
- B. Shop Drawings:
 - 1. Prior to detailed submission, submit preliminary layout showing head locations within coordinated ceiling grid and inspector's test station locations for review by Architect/Engineer.
 - 2. Submit shop drawings and obtain approval from all authorities prior to material purchasing, fabrication of any piping or installation of any components of the fire protection systems. Include detailed plans showing all piping, elevations of piping above finished floors, pipe sizes, hangers, supports, sprinkler heads, valves, siamese connections, concrete thrust block details, inspector's test locations, system drains, etc. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
 - 3. Hydraulic calculations: Submit flow test results and comprehensive hydraulic data sheets complying with NFPA 13. Verification of the adequacy of water pressure and other pertinent water supply data shall be the responsibility of the design engineer.
 - 4. Sprinkler heads shall be shown on Drawings and specifically identified by the style or series designation as published in the appropriate agency listing or approval.

- 5. Design systems under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal documents and shop drawings, including drawings and hydraulic calculations, shall bear the Responsible Engineer's signed and dated seal. Include all costs for obtaining approval from a Professional Engineer licensed in the State of Texas.
 - C. Product Data: Provide data on pipe materials, pipe fittings, sprinkler heads, valves, fire hose cabinets, flow switches, tamper switches, all other components and accessories. , Include manufacturer's catalogue information, code and standards compliance, performance ratings rough-in details, weights, support requirements, and piping connections.
 - D. Samples: Submit one (1) of each style of sprinkler head specified.
 - E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds requirements specified, and suggested by listed codes.
 - F. Certification of Installation: Provide a letter of certification stating that the installed and tested fire protection systems comply with the requirements of NFPA. The certification letter is to be authored, sealed, dated and signed by a licensed Fire Protection Engineer experienced in design and installation of this work and licensed in the state of Texas. Include all costs for obtaining approval from the licensed Fire Protection Engineer.
 - G. Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.
 - H. Project Record Documents
 - 1. Submit under provisions of Section 21 00 00.
 - 2. Record actual locations of sprinkler heads and deviations of piping from drawings. Indicate drain and test locations.
- 1.7 OPERATION AND MAINTENANCE DATA**
- A. Submit under provisions of Section 21 00 00.
 - B. Maintenance Instructions: Include installation instructions, spare parts lists, procedures, and treatment programs.
- 1.8 QUALITY ASSURANCE**
- A. Sprinkler Systems: Perform work to NFPA 13.
 - B. Welding Materials and Procedures: Perform to ASME BPVC, Section IX.

- C. Equipment and Components: Bear FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- D. Maintain one (1) copy of each document on site.
- E. Qualifications of the Installer: The system shall be installed by a firm regularly engaged in the design and installation of automatic sprinkler systems in accordance with requirements of the National Fire Protection Association and Fire Protection and the Texas Department of Insurance Fire Sprinkler Rules, or by an authorized agent of such firm. Evidence to support the above requirements may be required and any proposed installer who cannot show suitable experience will be rejected.
- F. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal documents and shop drawings shall bear the Responsible Engineer's signed and dated seal.
- G. All parts of fire protection piping systems shall conform to all provisions of Underwriters' Laboratories requirements. All equipment shall bear the Underwriters' Laboratories label of approval.
- H. Determine volume and pressure of incoming water supply from residual pressure water flow test.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be new, undamaged, and free of rust.
- B. Deliver, store, protect, and handle products to site under provisions of Section 21 00 00.
- C. Deliver and store valves in shipping containers with labeling in place.
- D. Inspect shipments for possible damage during transit. Do not use damaged materials in any part of the system.
- E. Provide temporary protective coating on cast iron and steel valves. fittings and valves not packaged within containers. Maintain in place until installation.
- F. Protect all materials that are to be installed within this Project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.
- G. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.10 EXTRA MATERIALS

- A. Furnish under provisions of Section 21 00 00.
- B. The Contractor shall provide spare heads equal to one percent (1%) of the total number of heads installed under the Contract, but not less than ten (10).
- C. The heads shall be packed in a suitable wall mounted metal storage cabinet and shall be representative of, and in proportion to, the number of each type and temperature rating heads installed. The cabinet shall be located where directed by the Construction Inspector.
- D. In addition to the spare heads, the Contractor shall provide not less than one (1) special sprinkler head wrench for each type of head.

1.11 WARRANTY

- A. The complete system shall be warranted in writing against defects in materials or Workmanship under normal use and service for a period of one (1) year after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. All piping, materials and equipment used in the installation of sprinkler system shall be new and listed as approved by the Underwriters' Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials and the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard and shall be the latest design of the manufacturer.
- C. Pressure ratings of pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the anticipated system pressures in which they are installed.
- D. The installing Contractor shall identify piping, fire department connections, valves and hydraulic design information in accordance with applicable NFPA Standards.

2.2 UNIONS

- A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines. Unions 2 inch and smaller shall be Class 300 AAR

threaded malleable iron unions with iron to brass seats, and 2-1/2 inch and larger shall be ground flange unions. Companion flanges on lines at various items for equipment machines and pieces of apparatus shall serve as unions to permit removal of the particular items.

2.3 FLANGES

- A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A181 Grade I or II or A105-71 as made by Tube Turns or Hackney-Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random.
- B. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications.
- C. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All thread rods will not be an acceptable for flange bolts.
- D. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

2.4 FLANGE GASKETS

- A. Gaskets shall be placed between the flanges of all flanged joints.
- B. Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick asbestos free material recommended for service by Anchor Seals, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.
- C. Spares: Contractor shall provide ten (10) spare gaskets for every flange size and rating.

2.5 WALL, FLOOR AND CEILING PLATES

- A. See Section 21 00 00.

2.6 SLEEVES, INSERTS, AND FASTENINGS

- A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, etc., shall be sleeved. Refer to Specification Section 21 05 29.

2.7 UNDERGROUND FIRE PROTECTION PIPING

- A. Acceptable Manufacturers: Pipe and joints shall be as manufactured in the United States by American Cast Iron Pipe Company, Tyler Pipe (a Division of McWane), U.S. Pipe Company, McWane Cast Iron Pipe Company, or Engineer accepted equivalent.

Commented [c1]: <http://www.tylerpipe.com/>

Commented [c2]: <http://www.clowvalve.com/communications/news-articles/mcwaneductile-iron-pipe-companies-unite-ner-one-name/>

B. Pipe

1. ANSI A21.50 (AWWA C150) and ANSI A21.51 (AWWA C151) cement mortar lined ductile iron, supplied in 16 ft. laying lengths.
2. Thickness
 - a. Piping 4" and Smaller: Class 51.
 - b. Piping 6" and Larger: Class 50.

C. Fittings

1. Class 250 AWWA C110, cement mortar lined, ductile or gray iron, standard thickness.
2. Tappings in ductile iron pipe shall be made with dual compression seal tapping sleeve, similar and Architect/Engineer accepted equivalent to U.S. Pipe Model T-28.
3. Joints
4. Ductile Iron Pipe to Ductile Iron Pipe: Unless noted otherwise on the Drawings, all joints shall be restrained mechanical joints.
5. Ductile Iron Pipe to Steel Iron Pipe: ANSI/AWWA C110 flanged fittings adequate for 250 psi working pressure. Provide with dielectric flange insulating kit with insulating sleeves and washers for each bolt.
6. Pipe to Valve: ANSI/AWWA C110 flanged fittings adequate for 250 psi working pressure.
7. Bolts: High strength, Type 316 stainless steel tee head bolts with hexagon nuts.
8. Gaskets: ANSI A21.11 / AWWA C111 ethylene propylene diene monomer (EPDM) suitable for 220°F.

- D. Coating: Pipe and fittings shall be cement mortar lined. Coat pipe and fittings outside with the manufacturer's standard asphaltic sealcoat in accordance with the latest revision of ANSI Standard A21.4 (AWWA C104) suitable for domestic water service.
- E. Casing: Unless otherwise noted on the Drawings, all ductile iron pipe, fittings, etc., shall be encased in 8 mils thick polyethylene tubing in accordance with the latest revision of ANSI Standard A21.5 (AWWA C105).
- F. Ductile iron piping, fittings, and joints shall be suitable for the minimum working pressure and sizes indicated on the Drawings, in Type 4 laying conditions with 2 to 15 feet of cover, and as required for freeze protection, unless otherwise indicated on the Drawings.

2.8 ABOVE GROUND FIRE PROTECTION PIPING

- A. All pipe used for fire protection fire sprinkler systems shall be Schedule 40 black steel pipe conforming to ASTM A795 or ASTM A53. All piping 2-1/2" and larger shall be welded, unless otherwise indicated herein.
- B. Use of mechanically coupled grooved piping, when approved by Stafford MSD, shall be "roll" grooved type; cut grooved pipe is not permitted.
- C. Schedule 10 and "thin wall" fire sprinkler pipe is not permitted.
- D. Fittings:
 - 1. Piping 2" and Smaller: Class 150 malleable iron threaded fittings conforming to ASME B16.3.
 - 2. Piping 2-1/2" and Larger: Welding type steel fittings conforming to ASTM A234 and ANSI B16.9. In lieu of welding type fittings, grooved type fittings may be used on sprinkler systems. Pipe size changes shall be performed through the use of reducing tees or reducers designed for that purpose. The use of bushings is explicitly prohibited.
 - 3. Grooved end couplings 2-1/2" and larger shall be Victaulic Style 07 "Zero-Flex" Rigid Coupling, with EPDM gasket (minimum 700 psi working pressure) for use with roll grooved piping. Products by Victaulic and Anvil are acceptable, or Engineer-approved equal. Reducing type couplings, outlet couplings, "T" outlet fittings, cut-in style fittings, snap joint couplings, and flange adapter type fittings are not acceptable. Provide grooved fittings similar to standard weld fittings.
 - 4. Extra heavy "Thread-o-lets" shall be used at each point of departure from the riser to the fire hose or valve cabinet. A "Thread-o-let" shall be installed below the level of the valve in the cabinet and a minimum of two (2) threaded ells shall be used to provide a swing joint connection from the riser to the valve in the cabinet.

2.9 VALVES

A. General:

1. All shutoff valves shall be UL listed and FM approved for fire protection service.
2. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.
3. All valves used to control the flow of water to and within sprinkler systems shall be listed indicating type complete with electric supervisory switches. Coordinate wiring with the Electrical Contractor.

B. Shutoff valves for sizes 2 inch and smaller:

1. Two (2) piece bronze ball valve, bubble-tight shutoff, full port, blow-out proof stem, chrome plated brass ball and silicon bronze stem, threaded end connections, conforming to MSS SP-110.
2. One (1) piece, butterfly valve, full port, threaded ends, bronze housing and body, stainless steel disc. EPDM disc seal and slow closing.
3. All valves shall be furnished with two (2) factory mounted internal supervisory switches.

C. Shut off valves for sizes over 2 inch:

1. Butterfly valves lug type with EPDM molded in seat liner, ductile iron disc, stainless steel stem, manual gear operator, conforms to MSS SP-67 and MSS SP-25, with integral supervisory switch. Where a grooved piping system is allowed, grooved end type butterfly valves may be used, consisting of ductile iron body and disc EPDM seats, stainless steel stem. Valves shall be equipped with internal supervisory switch.
2. Gate valves – OS&Y (Outside Yoke and Stem) resilient wedge, epoxy coated interior and exterior, ASTM A536 ductile iron valve body, bonnet and resilient wedge, ASTM B150 stem and flanged ends.

D. Check valves for sizes 2 inch and smaller:

1. Horizontal swing, bronze body, conforming to MSS SP-80, threaded ends and rubber disc.

E. Check valves for sizes over 2 inch:

1. Iron body swing-check, bronze disc, seat ring and hinge pin, UL listed and FM approved, flanged ends, renewable seats and disc, tapped 3/4 inch for ball drip assembly.

F. Standard of Quality for Fire Protection Valves:

Size	Type	Class	Manufacturer
2" and Smaller	Ball	300	Nibco No. KT-505-W-8, Stockham No. T-255-FB-P-UL
2" and Smaller	Butterfly	175	Milwaukee No. BB-SC02
2-1/2" and Larger	Butterfly (lug)	250	Nibco No. LD3510-8
2-1/2" and Larger	Butterfly (grooved)	300	Nibco No. GD-4765-8N
2 " and Smaller	Check	200	Nibco No. KT-403-W
2-1/2" and Larger	Check	175	Nibco No. F-908-W
2-1/2" and Larger	Check (grooved)	250	Nibco No. G-917 W

2.10 WET PIPE FIRE SPRINKLER SYSTEM

A. System Description:

1. System to provide coverage for entire building.
2. Provide system to the NFPA 13 occupancy requirements listed below, unless otherwise noted. Refer to "FP" drawings for locations of design densities of specific rooms and areas.

Location	System Type/Hazard
Administrative and Meeting Rooms	Light Hazard
Mechanical Equipment Rooms	Ordinary Hazard, Group 1
Electrical Equipment Rooms	Ordinary Hazard, Group 1

Location	System Type/Hazard
General Storage Areas	Ordinary Hazard, Group 1

3. Interface system with building fire and smoke alarm system.
4. Systems subject to freezing shall utilize antifreeze liquid. **DRY PIPE SYSTEMS ARE NOT ALLOWED.**

2.11 SPRINKLER HEADS

- A. Acceptable Manufacturers: Victaulic, Grinnell (Tyco), Viking, Star or Reliable.
- B. Suspended Ceilings and Gypsum Board or Plaster Ceilings:
 1. Type: Concealed pendant type, flexible concealed pendant, quick response.
 - a. Finish: Factory finished (no field painting) cover plate, color to match ceiling finish. Exception: Provide chrome plated or alternate color cover plates where directed by Architect.
 - b. Flexible sprinklers are permitted only in drop ceilings. Flexible sprinkler piping shall have UL-listed braided, angular corrugated flexible sprinkler hose. Hose shall have a minimum 2 in. bend radius and hose shall not have any bend connection restrictions without affecting hydraulics and safety of the material.
 2. Escutcheon Plate Finish: Standard white or chrome plated as selected by Architect.
 3. Operating Element: Fusible solder link or glass bulb type temperature rated for specific area hazard.
 4. Model: Sprinklers manufactured by Reliable, Victaulic or approved equal.
- C. Exposed Area Type (for areas such as mechanical rooms, electrical rooms, etc.):
 1. Type: Standard upright or pendent type with guard, quick response.
 2. Head Finish:
 - a. Conditioned spaces: Bronze.
 - b. Non-conditioned Spaces/Exterior: Corrosion resistant material (i.e. PTFE or Electroless Nickel PTFE).
 3. Operating Element: Fusible solder link or glass bulb type temperature rated for specific area hazard.

4. Model: GFR with appropriate wire guard as manufactured by Reliable or approved equal.
- D. Extended coverage sprinkler heads are not to be used.
- E. Sprinkler heads in elevator hoistways and elevator equipment rooms to be 200 degree F rated.
- F. Use only quick response sprinkler heads.
- G. Cold Rooms ($\leq 42^{\circ}\text{F}$) and Areas Below Heated Ceiling/Soffit Spaces Susceptible to Freezing: Provide dry pendant type with chrome finish and two-piece escutcheon. (Areas include but not limited to; walk-in freezers, exterior overhangs, canopies.)
- H. Elevator Equipment Rooms: Provide 212°F intermediate temperature classified heads.
- I. Water Alarm:
 1. A water motor alarm shall be connected to each alarm valve and shall discharge to a brass alarm gong located on the exterior of the building as directed by the Architect. Alarm gong finish to be selected by the Architect.
 2. The alarm valves shall be Underwriters' Laboratories approved, wet type, connected to water supply and indicated on the Shop Drawings. Each alarm valve shall be provided with a circuit closer. Valves shall conform to the equipment of NFPA 13, complete with retarding chamber and pressure switch.
- J. Water Flow Alarm Switch:
 1. Provide, where indicated on the Drawings, McDonnell UL approved line size flow switches.
 2. Flow switch shall be provided with delay, adjustable up to 90 seconds (60 to 90 seconds in Austin). See Division 26 for electrical signal connection by others to these flow switches.

2.12 FIRE DEPARTMENT SIAMESE CONNECTIONS

- A. At the points designated on the accompanying Drawings, install Siamese fittings required for fire protection purposes. From a point on the incoming water supply line, the Contractor shall extend water line for fire protection purposes to Siamese connections.
- B. Provide 2-way wall type Siamese connection equal to Potter Roemer No. 5750 series double clapper flush type Siamese connections with 2-1/2" outlets having threads complying with the requirements of the Fire Department of the City of Stafford, Texas. They shall have proper caps with pin type lugs attached to the body of the Siamese connections with substantial chains. The plate fitting against the building shall have

raised letters reading "AUTOMATIC SPRINKLER". All external surfaces shall be chromium plated polished surfaces or as directed by Architect.

- C. Provide 2 way free standing type Siamese shall be equal to Potter-Romer No. 5760 series cast brass body with 2-1/2" outlets and escutcheon. They shall have proper caps with pin type lugs attached to the body of connection with substantial chains. "AUTOMATIC SPRINKLER" is to be cast on head of connection. All external surfaces shall be chromium plated polished surfaces or as directed by Architect.
- D. Provide hose threads complying with the requirements of the local Fire Department.
- E. Products manufactured by Potter Roemer, Elkhart Brass or Larsen's will be acceptable.

PART 3 - EXECUTION

3.1 PREPARATION - ALL SYSTEMS

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Flush entire system of foreign matter prior to installation of sprinkler heads.

3.2 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Install all materials and products in accordance with manufacturer's published recommendations. Use tools manufactured for the installation of the specific material or product.
- C. Sprinkler Systems
 - 1. Install piping in accordance with NFPA 13 for sprinkler systems and NFPA 24 for service mains. Note that the piping sizes indicated in the plans are the minimum acceptable. The Qualified Contractor shall provide proper sizes, materials and installation as required in the appropriate NFPA Standard.
 - 2. Note that the use of piping bushings for any purpose is explicitly prohibited.
 - 3. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient. See Sections 21 00 00 and 21 05 29 for additional requirements.

4. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
5. Locate concealed valves, switches and alarm connections in accessible location, and coordinate size and location of access panels/doors with General Contractor.
6. Install valves with stems upright, not inverted. All valves shall be located such that the removal of their bonnets is possible. Valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. Remove protective coatings after installation.
7. Provide drain valves at main shut-off valves, low points of piping and apparatus. Provide Fire Department test station, piped to drain.
8. Locate outside alarm gong on building wall as indicated on the Drawings.
9. Place pipe runs to conserve building space, and to minimize obstructions with other work. Group piping whenever practical at common elevations. Coordinate closely with work of other trades to avoid conflicts and provide all required offsets, piping, auxiliary drains, etc. to properly install system.
10. Place piping in concealed spaces above finished ceilings. Run piping as high as possible, but a minimum of 12 inches above ceilings or proposed ceilings. Locate piping to avoid obstructing other work, including required service access to equipment furnished by other Divisions.
11. Heads shall be located in a symmetrical pattern related to ceiling features such as grid, beams, light fixtures, diffusers, etc., and where applicable, heads shall be located symmetrically with the ceiling grid, centered in two (2) directions.
12. Provide concealed sprinkler heads in 'public' areas such as corridors, student restrooms, commons, activity areas, locker rooms, etc. Apply paper cover to ensure concealed sprinkler head and cover plates do not receive field paint finish.
13. Provide semi-recessed sprinkler heads at classrooms, office and other staff occupied spaces.
14. Provide exposed sprinkler heads at all areas open to structure.
15. Provide wire guards on heads in all mechanical rooms, gymnasiums, and other areas where heads are subject to damage.
16. Sprinkler drop piping below ceiling configuration should be return bend (NFPA 13, Section 8.15.19) or flexible sprinkler drops shall be oriented such that the branch line connection is facing up.

17. Arm-overs greater than 24 inches shall be supported.
18. Install and connect fire pumps in accordance with Section 21 30 00 and NFPA 13.
19. Locate Fire Department Connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of Fire Department wrench handle.
20. Inspector's test valves shall be installed for each sprinkler control valve assembly equipped with a flow switch and piped to an acceptable location as defined below. Design installation of inspector's test drain to accommodate the flow of discharge water under full flow conditions with pump running. The test drain is to be closed-pipe with a sight glass located to verify flow. Discharge piping to a remotely located sanitary drain, sump, or equivalent, in accordance with NFPA requirements and not requiring the addition of a hose to accommodate flow within the building. Locate test/drain valves and sight glasses inside stairwells, wherever practicable. Test drain shall not be piped to mop sinks.
21. All black steel piping shall be primed and painted red at factory/fabrication shop. Do not paint threads or fittings.

3.3 WELDED PIPING

- A. Welding of pipe/fittings in normally occupied buildings is prohibited. Offsite welding is acceptable. Should welding be required in a normally occupied building for connecting to an existing welded system, obtain written approval from the Owner and comply with NFPA 51B.
- B. All welding materials, procedures, qualifications and records shall comply with applicable NFPA requirements.

3.4 SYSTEM CLEANING AND FLUSHING

- A. Cleaning, flushing and inspection shall be done in accordance with NFPA requirements.
- B. The installing Contractor shall complete and sign the appropriate Contractor's Material and Test Certificates included within NFPA 13 and 14. Tests and signing of test certificates shall be witnessed by Owner's Construction Inspector or designee.

3.5 ZONING

- A. All flow switches and tamper switches shall relay their activation to each annunciator panel and the main fire alarm panel.

- B. Sprinkler system zoning shall coincide with building smoke compartmentalization unless noted otherwise on Contract Drawings. As a minimum, each floor level shall be a separate zone.

3.6 ACCEPTANCE TESTING

- A. Pre-Acceptance Test: Prior to acceptance of the installation, subject the system to the test procedures as described by National Fire Protection Association Standards Nos. 13 and 24. Test pressures to be 200 psig minimum and are to be performed with all attached appurtenances. The duration of the test(s) to be a minimum of two (2) hours.
- B. Acceptance Testing: AHJ requires 48 hours advance notice for this test. Upon completion of the installation, subject the system to the test procedures as described by National Fire Protection Association Standards Nos. 13 and 24 and provide the Owner with a Contractor's material and test certificate for aboveground or underground piping as required therein. Test pressures to be 200 psig minimum and are to be performed with all attached appurtenances. The duration of the test(s) to be a minimum of two (2) hours. Completely flush new piping system after completion of test. Prior to acceptance testing provide a set of complete shop drawings to verify installation.

3.7 SIGNAGE AND IDENTIFICATION POINTS

- A. Install durable signage to indicate location of all shut-off and test valves. Locate signage in a commonly occupied/traveled location (e.g. hallway). Securely attach signage utilizing chains or other suitable methods. Provide signage with white letters and red background.
- B. Install identification point signage for all hidden water flow switches. Identification tags to be white letters on a red background. Locate in areas visible from hallways.

3.8 TRAINING

- A. Contractor shall provide for the service of a competent, trained and experienced agent to instruct and acquaint the Owner with the proper functioning, operation and maintenance of the fire protection systems and all installed components.

END OF SECTION 21 10 00

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COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019100. This contractor is responsible to comply with all requirements for the above section.

1.2 PLUMBING SYSTEM CRITERIA

- A. Domestic hot water temperature shall be limited to 110° F. except for water supplied to kitchen. Kitchens shall have a water supply temperature of 140° F.
- B. Gas piping on roofs shall be supported by manufactured free standing pipe supports.
- C. Water and gas lines under drives and walkways shall be sleeved with schedule 40 PVC, at least two pipe sizes larger than the supply line.
- D. The design of the roof drainage systems shall incorporate roof drains and overflows. The overflow system shall be piped independently and connected vertically to the roof drain down spout. The overflows shall be located in locations readily visible. (*Discharge overflow above grade if required by local Authority having jurisdiction).
- E. Lavatories serving students shall have single, self closing faucets. Learning Center sinks shall have single faucets with goose necks. All sinks to include cold, tempered and hot water not to exceed 105
- F. In each science learning center/wet lab, provide a red emergency shut off button to shutdown water, gas and electricity in event of an emergency. Locate this button in the teacher's workstation and away from exit door.

1.3 SUMMARY

- A. Design a complete plumbing system including all sanitary, waste and vent piping, storm piping, gas piping and all equipment necessary for a complete system and in accordance with all local jurisdictions and codes.
- B. All materials and distribution, and utilization equipment shall be UL Listed.
- C. All equipment and materials shall be new, unused and of United States Domestic manufacture.
- D. Provide hot and cold and tempered water isolation valves at every supply pipe to each restroom or restroom bank.
- E. Isolation valves shall be accessible in all restrooms. The contractor shall provide a minimum of 2 feet accessible pipe chase for maintenance.

- F. All cleanouts shall be accessible. Any room that has a plumbing fixture shall have an accessible isolation valve.
- G. A record shall be kept of all permits and inspections and submitted to the Master Plumber. In addition, a list of all equipment and devices will be provided.
- H. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.
- I. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.
- C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.5 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.6 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
 2. CPVC Piping: ASTM F 493.
 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.7 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC PVC CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
1. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.
- 2.8 DIELECTRIC FITTINGS
- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F
- D. Coordinate subparagraph and associated subparagraphs below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.

- f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- F. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
- 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F
- 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
- 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.9 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.10 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Under-deck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.11 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.12 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - i. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - j. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- ### 3.2 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
 - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Sprinklers Systems" for fire-suppression piping.
 - 3. Section 013300 Submittals.
 - 4. Section 01524 Construction Waste Management
 - 5. Section 01352 LEED Requirements
 - 6. Section 01611 Environmental Management
 - 7. Section 01570 Pollution Prevention and Control

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for "The Valve and Fittings Industry Inc".
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.
 - 4. Pipe positioning systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.
- D. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.5 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Carpenter & Paterson, Inc.
 - 3. Globe Pipe Hanger Products, Inc.
 - 4. Grinnell Corp.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.6 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.7 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 1. B-Line Systems, Inc.; a division of Cooper Industries.
 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 3. GS Metals Corp.
 4. Power-Strut Div.; Tyco International, Ltd.
 5. Thomas & Betts Corporation.
 6. Tolco Inc.
 7. Unistrut Corp.; Tyco International, Ltd.

- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.8 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

- B. Manufacturers:
 1. Engineered Products, Inc.
 2. Insulation Carpenter & Paterson, Inc.
 3. ERICO/Michigan Hanger Co.
 4. PHS Industries, Inc.
 5. Pipe Shields, Inc.
 6. Rilco Manufacturing Company, Inc.

- C. Value -Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.9 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - d. MKT Fastening, LLC.
 - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

2.10 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. All piping on roof shall be supported by roof mounted pipe hangers. No wood is allowed.
- C. All Pipe support system on roof shall be sized / designed by manufacturer and installed by this contractor. The pipe support system shall be suitable for the insulated chilled water and hot water piping system as indicated on drawings. Pipe support system must be provided with the following requirements:
1. Bottom of the pipe must be 18" above roof finished level.
 2. Pipe support spacing shall be based on the maximum roof load of 2.5 # / sq-inch. Contractor must size the pedestal base area for each support in coordination with the required support spacing such that the total load on roof does not exceed 2.5 # / sq-inch.
 3. Submit the proposed scheme to the engineer for approval before material procurement or installation of any work.
 4. Contractor is responsible to price all the support system at the project bid stage.
 5. Contractor is responsible to coordinate all the support system with the roofing drawings of this package.
 6. Provide expansion loops and floating support system in accordance with requirements.
 7. The support channels and plate frames indicated on the drawings are the required minimum standards. Support system vendor must verify the loads on each section and upgrade as necessary.
- D. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. PHP Systems

- E. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. MIRO Industries (or equal).
 - b. PHP Systems

- F. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

- G. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. Portable Pipe Hangers.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers
 - 2. Bases: One or more plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- H. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.11 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

- B. Manufacturers:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.

2.12 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.13 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 3. Carbon or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weld less Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.

- b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 - 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 - 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 - 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 - 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 - 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricated from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Each metal framing system in paragraph below requires calculation and detail.
- E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- F. Each fiberglass strut system in first paragraph below requires calculation and detail.
- G. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- H. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- I. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- J. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- K. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- L. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- M. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- N. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- O. Install lateral bracing with pipe hangers and supports to prevent swaying.
- P. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- Q. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- R. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- S. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inch long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
- B. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- C. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 RELATED SECTIONS:

- A. Section 013300 Submittals.
- B. Section 01524 Construction Waste Management
- C. Section 01352 LEED Requirements
- D. Section 01611 Environmental Management
- E. Section 01570 Pollution Prevention and Control

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.
- F. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:

- a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
- b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.5 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.6 PIPE LABELS

- A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.7 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.8 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook wire-link chain beaded chain S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.9 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Reinforced grommet and wire or string.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels color-coded bands or rectangles complying with ASME A13.1 on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:

1. Domestic Water Piping:
 - a. Background Color: Blue.
 - b. Letter Color: Black.
2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Other valve-tag sizes, shapes, colors, and letter colors may be available if required.
 2. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - c. Low-Pressure Compressed Air: 1-1/2 inches, round.
 3. Select contrasting valve-tag color and letter color in two subparagraphs below for each service. Retain "Natural" option for brass or stainless-steel valve tags.
 4. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 5. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Phenolic.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied jackets.
9. Tapes.
10. Securements.
11. Corner angles.

B. Related Sections include the following:

1. Section 013300 Submittals.
2. Section 01524 Construction Waste Management
3. Section 01352 LEED Requirements
4. Section 01611 Environmental Management
5. Section 01570 Pollution Prevention and Control

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 6. Detail application of field-applied jackets.
 7. Detail application at linkages of control devices.
 8. Detail field application for each equipment type.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - b. Sheet Form Insulation Materials: 12 inches square.
 - c. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - d. Sheet Jacket Materials: 12 inches square.
 - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- E. Qualification Data: For qualified Installer.
- F. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- G. Field quality-control reports.
- H. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
 - 1. Piping Mockups:
 - a. One 10-foot section of NPS 2 straight pipe.
 - b. One each of a 90-degree threaded, welded, and flanged elbow.
 - c. One each of a threaded, welded, and flanged tee fitting.
 - d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
 - e. Four support hangers including hanger shield and insert.
 - f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
 - 2. Equipment Mockups: One tank or vessel.
 - 3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 - 4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 5. Obtain Architect's approval of mockups before starting insulation application.
 - 6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 8. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 INSULATION MATERIALS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. Armstrong World Industries, Inc.
2. Certainteed Corp.
3. Knauf Fiber Glass GmbH.
4. Owens-Corning Fiberglas Corp.
5. Pittsburgh Corning Corp.
6. FGH Fabricators, Inc.

- B. Adhesives shall be as manufactured by Minnesota Mining, Arabol, Benjamin-Foster, Armstrong, or Insulmastic, Inc., and shall have the same adhesive properties, fire rating, vapor seal, etc., as the types specified herein, subject to review by the Engineer.

2.5 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated. (Indoor locations).
- B. Foam Glass Insulation: ASTM C552-07, class 1 for all outdoor installation / applications.
- C. Jackets for Piping Insulation: ASTM C 921, Type I (vapor barrier) for piping with temperatures below ambient, Type II (water vapor permeable) for piping with temperatures above ambient. Type I may be used for all piping at Installers option.
1. Encase pipe fittings insulation with one-piece pre-molded 16 MIL aluminum fitting covers, fastened as per manufacturer's recommendations.
 2. Encase exterior piping insulation with 16 MIL aluminum jacket with "Z" closures for weather-proof construction.
- D. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated. White all service jacket "ASJ" vapor barrier with dual self-seal strips for all insulation except flexible unicellular.

2.6 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot.

2.7 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 97-13.
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. ITW TACC, Division of Illinois Tool Works; CB-25.
 - d. Marathon Industries, Inc.; 501.
 - e. Mon-Eco Industries, Inc.; 55-10.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 - d. Mon-Eco Industries, Inc.; 55-70.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.9 PLUMBING PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, buried piping, fire protection piping, and pre-insulated equipment.

2.10 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Domestic hot-water pump insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Phenolic: 1 inch thick.
- D. Domestic cold water, and domestic hot-water hydro-pneumatic tank insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber Pipe and Tank: 1 inch thick.
- E. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
 1. Cellular glass.
 2. Mineral-fiber pipe and tank.
 3. Phenolic.

2.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

2.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.

- B. Domestic Hot water and Re-circulated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- C. Storm water and Overflow:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- D. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Polyolefin: 3/4 inch thick.
- F. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.

2.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
- D. Piping, Exposed:
 - 1. PVC, Color-Coded by System: 20 mils 30 mils thick.
 - 2. Aluminum, Smooth 0.024 inch thick.

2.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

- C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

- D. Piping, Exposed:
 - 1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

2.15 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220700

22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Flexible connectors.
5. Water meters.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Wall penetration systems.

B. Related Sections:

1. Section 013300 Submittals.
2. Section 01524 Construction Waste Management
3. Section 01352 LEED Requirements
4. Section 01611 Environmental Management
5. Section 01570 Pollution Prevention and Control

1.3 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Fire-suppression-water piping.
2. Domestic water piping.
3. Natural Gas piping.

- D. Field quality-control reports.
- E. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.
- C. Comply with NSF 61 for potable domestic water piping and components.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.

- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 WATER SUPPLY SYSTEM:

- A. A complete system of hot and cold water supply to all plumbing fixtures and mechanical equipment shall be supplied and installed as shown on the Drawings. The water supply system shall be installed using the materials and methods as specified in the following paragraphs.

B. UNDERGROUND WATER PIPING SYSTEMS:

- 1. Pipe: All pipe used for underground water piping mains shall be Class 52 centrifugally cast, close grained cast iron pipe or Class 50 DUCTILE iron pipe arranged with bell and spigot mechanical joints.
- 2. Valve Boxes:
 - a. For each underground valve installed by the Contractor, the Contractor shall provide and install a two-piece, screw adjustable type valve box. These valve boxes shall be designed for heavy roadway service and they shall have a deep socket type of cover which prevents their being accidentally knocked out of position.

- C. The word "WATER" shall appear on each cover. The installation of these members shall be such that by the use of the adjustable screw type bodies the tops are just flush with the finished grade. These valve boxes shall be Tyler Pipe Industries #6850, or approved equal.

- 1. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

D. IRRIGATION PROVISIONS:

- 1. Furnish and install capped and/or valved water lines under paving, through retaining walls in paved plaza areas and as indicated on Drawings for connections and extensions under work of Section Irrigation (Sprinkler) System.

E. BUILDING ENTRANCE:

1. A metallic sleeve shall be inserted in the forms of the building wall through which the water service enters the building. The interior diameter of such sleeve shall be four inches (4") greater than the exterior diameter of the water service.
2. The water service pipe from within the building shall be extended to a point five feet outside the building wall through this sleeve. The position of the water service in this sleeve shall be concentric and the intervening space shall be packed in a flexible manner to avert the flow of water from outside of the building into the basement.
3. The interior pipe extended outside the building shall be provided with a protective wrapping of "Tape Coat" SP warmed with hand torch. This protective tape shall be applied with "half lap" coverage in strict accordance with the manufacturer's published instructions. The cast iron pipe connected to the pipe extending from the building wall shall contain two caulked joints within four feet of the union of the cast iron pipe and the interior pipe from the building.

2.5 REQUIREMENTS OF INTERIOR WATER PIPING SYSTEMS:

- A. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.
- B. All exposed chrome plated, polished or enameled connections from fixtures shall be put up with special care, showing no tool marks or threads at fittings, and supported by neat racks or hangers with round head screws of same material and finish.
- C. Wade Shok-stop, or approved equal, sealed air chambers shall be provided in all water branches to fixtures, sized in accordance with manufacturer's recommendations, concealed, accessible, and located so as to protect each group of plumbing fixtures.
- D. The fabrication of copper pipe and fittings shall in every detail conform to the recommendations and instructions of the fitting manufacturer. The tools used shall be the tools adapted to that specific purpose.

2.6 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper shall be used for all domestic cold, hot water and hot water return piping up to and including 4" for above grade applications.
 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Interior domestic water piping of 6" and larger shall be schedule 40 galvanized steel to ASTM A53.

2.7 DUCTILE-IRON PIPE AND FITTINGS (FOR UNDERGROUND USE)

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
 2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
 - a. Gaskets: AWWA C111, rubber.
 - 2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
 - a. Gaskets: AWWA C111, rubber.
- C. Plain-End, Ductile-Iron Pipe: AWWA C151.
 - 1. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International.
 - 2) Shurjoint Piping Products.
 - 3) Star Pipe Products.
 - 4) Victaulic Company.
 - b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 - c. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.8 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.9 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.10 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc; a Sensus company.
 - g. Viking Johnson; c/o Mueller Co.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
2. Description: CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.

2.11 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products.
2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.
2. Description:
 - a. Non-conducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
2. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and noncorrosive, thermoplastic.

2.12 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber-Booth.
 2. Triplex.
 3. Mercer Rubber Co.
 4. Metraflex, Inc.
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.13 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. Split Casting, Cast Brass: Polished, chrome-plated or rough-brass finish with concealed hinge and setscrew.
- C. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.14 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
- B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.15 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex, Inc.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.16 WALL PENETRATION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. SIGMA.
- B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
 - 1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
 - 2. Housing: Ductile-iron casting with hub, water stop, anchor ring, and locking devices. Include gland, bolts, and nuts.
 - 3. Housing-to-Sleeve Gasket: EPDM rubber.
 - 4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
 - 5. Pipe Sleeve: ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Provide shut-off valve for each battery of fixtures located above ceiling near each bathroom.
- C. All buried piping shall be buried a minimum of 30" below finished grade including domestic water.

- D. Install underground ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Valves 2-1/2" and smaller shall be cast brass with stainless steel ball and stem; 3" and larger shall be gate valves.
- H. Butterfly valves are not acceptable for any plumbing applications.
- I. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- J. Install domestic water piping level and plumb.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping adjacent to equipment and specialties to allow service and maintenance.
- N. Install piping to permit valve servicing.
- O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- P. Install piping free of sags and bends.
- Q. Install fittings for changes in direction and branch connections.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- T. Install thermostats in hot-water circulation piping. Comply with requirements of the latest International Energy Code.
- U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.2 TESTING AND STERILIZATION

- A. All water piping systems shall be properly tested to assure their being absolutely tight. In the case of pipes which are to be insulated, these tests shall be completed and the piping system proven to be absolutely tight before any insulation is applied. Wherever pipes are placed so that they will ultimately be concealed, these tests shall be conducted and the absolute tightness of each piping system shall be demonstrated before the system is concealed.
- B. The procedure of these tests shall consist of subjecting a piping system to a hydrostatic pressure per Section 23 00 00. During the test period, all pipe, fittings and accessories in the particular piping system which is being tested shall be carefully inspected. If leaks are detected, such leaks shall be stopped by means designated by the Owner's duly authorized representative and the hydrostatic test shall again be applied. This procedure shall be repeated until, for an entire twenty-four hour period, no leaks can be found while the system being tested is subjected to the pressure mentioned above.
- C. Wherever conditions permit, each piping system shall thereafter be subjected to its normal operating pressure and temperature for a period of no less than five (5) days. During that period, it shall be kept under the most careful observation. The piping systems must demonstrate the propriety of their installation by remaining absolutely tight during this period. Even though the completion of these tests is satisfactory, there is a continuing responsibility for the ultimate, proper, and satisfactory operation of such piping systems and their accessories.
- D. After completion of the testing, the entire cold and hot water piping systems, with attached equipment, shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. The chlorinating materials shall be either liquid chlorine conforming to U. S. Army Specification No. 4-1 or calcium hypochlorite or chlorinated lime conforming to the requirements of Federal Specification O-C-114. The sterilizing solution shall be allowed to remain in the system for a period of eight (8) hours during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million.
- E. The sterilization process shall be conducted as required by the Health Department of the "City of Houston", and the specifications above, and upon completion of the process, the Health Department shall test and certify the cleanliness of the water piping system. The Plumbing Subcontractor shall pay all costs and charges incidental to this test and certification.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.

- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- G. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- H. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
- I. Steel-Piping Grooved Joints: Cut or roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- J. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly for piping NPS 2-1/2 and larger.
- B. Butterfly valves are not acceptable for any plumbing applications.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.5 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements for plumbing fixture for connection sizes.
3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow it to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow it to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use gate, ball valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use globe or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019100. This contractor is responsible to comply with all requirements for the above section.

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated water mixing valves.
 - 6. Strainers.
 - 7. Hose bibbs.
 - 8. Wall hydrants.
 - 9. Drain valves.
 - 10. Water hammer arresters.
 - 11. Air vents.
 - 12. Trap-seal primer valves.
 - 13. Trap-seal primer systems.
- B. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

- E. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. J. R. Smith Corporation.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Legend Valve.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
 - 2. Standard: ASSE 1011.
 - 3. Body: Bronze, non-removable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Chrome or nickel plated.

2.5 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. FEBCO; SPX Valves & Controls.

- b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Plumbing Products Group; Wilkins Div.
 2. Standard: ASSE 1013.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 5 psi maximum, through middle 1/3 of flow range.
 5. Size: As indicated on drawings.
 6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 8. Configuration: Designed for horizontal, straight through flow.
 9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- B. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 2. Standard: ASSE 1047 and FMG approved or UL listed.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 7 psig maximum, through middle 1/3 of flow range.
 5. Size: As indicated on plans.
 6. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
 7. End Connections: Flanged.
 8. Configuration: Designed for horizontal, straight through flow.
 9. Accessories:
 - a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
 - c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

2.6 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Flo Fab Inc.
 - c. ITT Industries; Bell & Gossett Div.
 - d. NIBCO INC.
 - e. Taco, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
 3. Body: bronze,
 4. Size: Same as connected piping, but not larger than NPS 2.
 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.7 TEMPERATURE-ACTUATED WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Honeywell Water Controls.
 - c. Powers; a Watts Industries Co.
 - d. Symmons Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Factory-installed, hose-end drain valve.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.
 - d. Plastic Oddities; a division of Diverse Corporate Technologies.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Include operating key with each operating-key hose bibb.
14. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Non-freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.14 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - EXECUTION

3.1 INSTALLATION

- #### A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

3. Do not install bypass piping around backflow preventers.
 4. Backflow preventer shall be certified by Contractor.
 5. Provide a floor drain within six (6) feet of each backflow preventer.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
 - C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
 - D. Install balancing valves in locations where they can easily be adjusted.
 - E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install thermometers and water regulators if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
 - F. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pump.
 - G. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 1. Install shutoff valve on outlet if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
 - H. Install freeze-resistant yard hydrants with riser pipe set in concrete or pavement. Do not encase canister in concrete.
 - I. Install water hammer arresters in water piping according to PDI-WH 201.
 - J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
 - K. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
 - L. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
 - M. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
 - 4. Primary, thermostatic, water mixing valves.
 - 5. Primary water tempering valves.
 - 6. Hose stations.
 - 7. Supply-type, trap-seal primer valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 22 13 01 – SANITARY SEWERAGE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Buried sewer pipe and fittings.
- B. Exposed and embedded soil, waste, drain, and vent piping.
- C. Valves.
- D. Floor drains.
- E. Gutter and trench drains.
- F. Battery room floor drains.
- G. Cleanouts.
- H. Piping specialties.
- I. Flashings.
- J. Escutcheons.
- K. Neutralizing sumps.
- L. Sewage ejectors.
- M. Interceptors and tanks.

1.02 RELATED SECTIONS

- A. Site sanitary sewerage system is specified in Section 33 31 00 - Sanitary Utility Sewerage Piping. Coordinate the work of this Section with the work of Section 33 31 00 - Sanitary Utility Sewerage Piping, as required for a complete and finished sanitary sewerage system.

1.03 MEASUREMENT AND PAYMENT

- A. Separate measurement or payment will not be made for the work required under this Section. All costs in connection with the Work specified herein will be considered to be included or incidental to the Work of this Contract.

1.04 REFERENCES

- A. American Society for Testing and Materials (ASTM):
1. ASTM A48 Specification for Gray Iron Castings
 2. ASTM A74 Specification for Cast Iron soil Pipe and Fittings
 3. ASTM D4021 Specification for Glass-Fiber-Reinforced Polyester Underground Petroleum Storage Tanks
 4. ASTM C4 Clay Drain Tile
 5. ASTM C14 Concrete Sewer, Storm Drain, and Culvert Pipe (ASTM C14M Concrete Sewer, Storm Drain, and Culvert Pipe [Metric]).
 6. ASTM C425 Compression Joints for Vitrified Clay Pipe and Fittings.
 7. ASTM C443 Joints for Circular Concrete Sewer and Culvert Pip, Using Rubber Gaskets (ASTM C443M – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets [Metric]).
 8. ASTM C564 Rubber Gaskets for Cast iron Soil Pipe and Fittings.
 9. ASTM C700 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
 10. ASTM C1053 Borosilicate Glass Pipe and fittings for Drain, Waste, and Vent (DWV) Applications.
 11. ASTM D1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 12. ASTM D2235 Solvent Cement for Acrylonitrile – Butadiene – Styrene (ABS) Plastic Pipe and Fittings.
 13. ASTM D2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 14. ASTM D2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
 15. ASTM D2661 Acrylonitrile – Butadiene – Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
 16. ASTM D2662 Polybutylene (PB) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
 17. ASTM D2665 Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
 18. ASTM D2666 Polybutylene (PB) Plastic Tubing.
 19. ASTM D2683 Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe.

- 20. ASTM D2729 Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 21. ASTM D2751 Acrylonitrile – Butadiene – Styrene (ABS) Sewer Pipe and Fittings.
- 22. ASTM D3034 Type PSM Poly (Vinyl Chloride) Sewer Pipe and Fittings.
- 23. CISPI 301 Coast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems
- 24. CISPI 310 Joints for Hubless Cast Iron Sanitary Systems.

B. Manufacturer's Standardization Society of Valve and Fitting industry (MSS):

- 1. MSS SP-70 Cast Iron Valves, Flanged and Threaded Ends
- 2. MSS SP-80 Bronze Gate, Globe, Angle and Check Valve

1.05 SUBMITTALS

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Shop Drawings: Submit Shop Drawings showing piping layouts, sizes, types, valves, drains, cleanouts, sewage structure ejector station, and air compressor assembly.
- C. Product Data: Submit manufacturers' product data for specified materials and equipment.
- D. Operation and Maintenance Data: Submit equipment manufacturer's printed operating and maintenance instructions in accordance with Section 01 78 23 - Operation and Maintenance Data, consisting of detailed parts list, recommended spare parts list, and complete operation and maintenance procedures.
- E. Test Reports: Submit certified test reports of valves and equipment, as applicable.

1.06 SITE CONDITIONS

- A. Excavations shall be dry immediately before and after products are installed. Provide surfaces and structures to, and on, which sewerage products will be installed capable of supporting the products. Complete construction, which will be concealed by sewerage products before sewerage products are installed.
- B. Coordinate the installation of the sanitary sewerage system with other building systems and components so as to avoid conflicts of installation. Drawings are diagrammatic and not necessarily to scale. Do not scale drawings for exact locations of installation of pipelines, valves, and equipment.

PART 2 - PRODUCTS

2.01 BURIED SEWER PIPE AND FITTINGS

- A. Piping below grade shall be Class H as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.
- B. Piping buried below slabs on grade and piping in the crawl space under platform slabs shall be cast iron sewer pipe, Class B, as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, or ASTM A74 bell-and spigot cast iron sewer pipe with joints made tight and sealed in accordance with Engineer-approved shop details.
- C. Ejector pump discharge lines shall be Class H as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.
- D. Acid waste, drainage, and vent piping shall be Class H pipe and fittings as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.

2.02 EXPOSED AND EMBEDDED SOIL, WASTE, DRAIN, AND VENT PIPING

- A. Provide Class B cast iron soil pipe and fittings as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, for non-pressure piping.
- B. Provide Class E copper tube as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC s, for HVAC condensate pan drain.
- C. Provide Class C steel pipe and fittings as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, for ejector pump discharge.

2.03 VALVES

- A. General: Provide valves of types indicated.
- B. Gate and Check Valves: Refer to Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, for gate valves and swing check valves.
- C. Backwater Valves: Provide backwater valves with cast iron bodies, hinged flaps, and seats, bolted covers, bronze trim, and flaps and seats removable through covers. Disc shall allow leakage, which will eliminate blocking of the valve by the bridging of solids on the upstream side. Flaps shall be sensitive to backflow, and capable of closing immediately upon backflow.
- D. Trap Primer Unit: Provide automatic trap primer valve, copper or cast bronze, 150 psi operating pressure, solder joint ends, with internal air gap, in-line type, complete with distribution unit.

2.04 FLOOR DRAINS

- A. Provide floor drains manufactured of heavy cast iron with double drainage flange, sediment bucket, integral seepage pan, trap primer connection, and clamping collar for waterproofing membrane.
- B. Provide heel proof strainer of chromium-plated cast brass, polished brass or buff polished nickel alloy, as indicated, sized to match floor drain and attached to a bronze threaded collar for adjustment to varying floor thickness.
- C. Provide cast-iron extra heavy traffic pattern floor drains where indicated.

2.05 GUTTER AND TRENCH DRAINS

- A. Provide gutter and trench drains manufactured of heavy cast iron with sediment bucket, integral anchor flange and flashing clamp where membrane is provided. Provide cast iron, extra heavy traffic pattern gutter trench drains, where indicated. Provide cast ductile iron anti-tilt grate unless otherwise indicated.
 - 1. Coordinate with the requirements for trench drains specified in Section 05 50 00 - Metal Fabrications.

2.06 BATTERY ROOM FLOOR DRAIN

- A. Cast iron body with acid resistant enameled interior and enamel coated dome strainer, bottom outlet with aperture joint to suit PVC pipe connection, heavy-duty, round flange flashing collar with weepholes.

2.07 CLEANOUTS

- A. Provide cleanouts of cast iron conforming to ASTM A48, Class 25B and of sizes indicated.
- B. Floor cleanouts shall be adjustable type, and shall have scoriated nickel alloy cover and, if for membrane waterproofed floors, a clamping device.
- C. Wall cleanouts shall be bolted wedge type having a cover. Cover shall be satin stainless steel in flanged frame secured to plug with a vandal-proofscrew.
- D. Exposed cleanouts shall have raised brass head cleanout plug.
- E. Grade cleanouts shall have adjustable sleeve-type housing, threaded brass plug with countersunk slot, and cast iron frame and cover.

2.08 PIPING SPECIALTIES

- A. Gaskets for flanged joints shall be as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.
- B. Couplings for connecting above ground and underground piping shall be specifically designed for the purpose required with transition type gaskets.

2.09 FLASHINGS

- A. Provide either soft-tempered or cold-rolled copper, weighing not less than 16 ounces per square foot, or sheet lead, weighing not less than four pounds per square foot.

2.10 ESCUTCHEONS

- A. Provide as specified in Section 20 20 13 - Pipe Sleeves, Supports and Anchors for Facility Services

2.11 NEUTRALIZING SUMPS

- A. Provide sump molded in one piece from polyethylene with NPT connections and having minimum capacity of 15 gallons or 1.33 cubic feet of usable volume.
- B. The sump shall be completely filled with marble chips, and furnished complete with gasketed, bolted polyethylene cover.

2.12 SEWAGE EJECTOR

- A. Provide in accordance with Section 22 14 29 - Sump Pumps.

2.13 INTERCEPTORS AND TANKS

- A. Interceptors:

1. Interceptors shall be of epoxy-coated, cathodic-protected, steel of double wall construction with hydrostatic or dry well leak detector in annulus or waterproofed concrete with minimum of two compartments. Provide three 24-inch minimum diameter manholes with removable covers designed for TXDOT's H 20 trafficloads.
2. Provide floating type light oil and fuel skimmer in each interceptor with gravity drain to waste oil tank; 3 inches diameter minimum; 1/2 inch per foot slope. Skimmer buoyancy shall be adjustable to allow skimming 0.90 to 0.94 specific gravity floating material.
3. The manholes shall be located at interceptor ends for access to each compartment and centered over compartment partition for access to skimmer. Provide a plumbing vent terminating minimum of 10 feet above grade for each interceptor.
4. The leak detector for double wall steel interceptors shall be located in the Mechanical or Electrical Room, as applicable, and a leak alarm shall be transmitted to Central as indicated on the Contract Drawings.

- B. Tanks:

1. Tanks shall be of glass fiber-reinforced polyester plastic conforming with ASTM D4021. Tanks shall be equipped with 22 inches minimum inside diameter manway with bolted and gasketed cover, 36 inches minimum diameter by 36 inches minimum high compartment above, and 24 inches diameter heavy duty traffic pattern manhole cover at grade.
2. Tanks shall be furnished complete with 2 inches vent, terminating a minimum 10 feet above grade; 3 inches capped pump out connection with spill containment box with traffic pattern cover at grade, and level gage with remote dial indicator and high level alarm installed in the Mechanical or Electrical Room, as applicable. Tanks shall be of double wall

construction with hydrostatic type leak detector or enclosed in concrete vault with floor mounted moisture type detector.

3. The leak detection panel, level gage, and high level alarm shall be located in the Mechanical or Electrical Room, as applicable, and alarms shall be transmitted to Central as indicated on the Contract Drawings.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Excavations shall be free of water and extraneous material immediately before sanitary sewerage products are installed or placed. Bottoms of trenches shall have a 6 inch sand bed and shall be formed to support the bottom quadrant of the pipe and fittings. Should rock be encountered or should bedding material be unsuitable to support the products at indicated elevation, continue excavation to an elevation 8 inches below the indicated elevation and backfill with clean sand to the indicated elevation.
- B. Interior of pipe, pipe fittings, valves, drains, and cleanouts shall be cleaned of dirt and foreign substances before installation.
- C. Install sleeves through walls, floors, roofs, and other structures before sewerage lines are installed. Piping shall not be installed under walls, foundations, or footings. Invert of sleeves shall be minimum 6 inches above the bottom of footings and foundations.

3.02 INSTALLATION

- A. Excavating and backfilling, including bedding and compacting requirements, shall conform to Section 33 05 28 - Trenching and Backfilling for Utilities.
- B. Install products where indicated. Remove and reinstall products that are disturbed after installation. Ends of products to which future connections will be made shall be valved, plugged, or capped, and anchored.
- C. Connections to existing facilities shall be made with fittings and short bends to suit the actual conditions; connect products in accordance with the product manufacturer's printed installation instructions.
- D. Pipe and fittings shall be set true to line and grade before joints are made up. Angular deflections of joints shall not exceed the recommendations of the pipe and fitting manufacturer. Should the alignment require deflection of joints to be in excess of those recommended, use special bends to achieve the indicated deflection. Pipe ends and joints shall be prepared in accordance with the manufacturer's recommendations. As a minimum pipe ends shall be sanded and cleaned, fittings shall be cleaned, and solvent shall be applied to both pipe and fittings.
- E. Slope horizontal soil and waste pipes a minimum 2% downward in direction of flow. Extend main vertical soil and waste stacks full size to the roof-line and above as vents, except where otherwise specifically indicated. Run vent pipes in roof spaces as close as possible to the underside of the roof without forming traps in pipe, using fittings as required. If a circuit vent pipe from fixture, or line of fixtures, will be connected to a vent line serving other fixtures, the connection shall be at least 6 inches above the flood-level of the highest fixture served. Grade and connect vent and branch-vent pipes to drip back to the vertical stack by gravity. Support all above grade piping in accordance with 15065, Pipe Sleeves, Supports, and Anchors.

- F. Install wall sleeves and seals in accordance with 15065, Pipe Sleeves, Supports, and Anchors. Sealing members shall be installed so as to provide electrical isolation between the metallic carrier pipe and all metallic components of the sleeve and seal.
- G. Make changes in pipe size on soil, waste, and drain lines with reducing fittings. Changes in direction shall be with either 45-degree wyes long or short-sweep 1/4, 1/6, 1/8 or 1/16 bends, or elbows.
- H. Slip joints will be permitted only in fixture trap seals on the inlet side of the traps.
- I. Installation of pipe and fittings shall comply with the manufacturers' recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted.
- J. Joints in no hub cast iron soil pipe and fittings shall use double-seal, compression-type molded neoprene gasket, which shall provide a positive seal.
- K. Tighten band and screw assemblies used in conjunction with hubless type cast iron pipe to 60-inch pounds torque on each band screw, with a torque wrench specifically designed for the purpose.
- L. Provide escutcheons at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, and ceilings. Fasten escutcheons to pipe or pipe covering.
- M. Equip each fixture and piece of equipment connecting to the sanitary sewer system with a drain trap located as near fixture as possible, and no fixture shall be double-trapped.
- N. Provide acid-proof piping in locations indicated. Install acid-proof piping separate from other waste piping, and connect to neutralizing sump, then to other sanitary piping only at mains.
- O. Drains:
 - 1. Floor drain rim elevation shall be located such that uniform slope of 1-1/2 percent is maintained from the furthest distance at the perimeter of slab to rim. There shall be no local depression.
 - 2. Unless otherwise indicated, floor, shower, and trench drains connected to sanitary sewers shall be trapped.
 - 3. All below grade traps in public restrooms shall be provided with trap primers.
 - 4. Maintain integrity of waterproof membranes where penetrated by installing flashing collar or flange so that no leakage occurs between drain and adjoining materials.
 - 5. Position drains and neutralizing sumps so that they are readily accessible and easy to maintain.
- P. Provide access panels in accordance with Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.
- Q. Interceptor and Tank Installation: Manhole covers shall be set with frame in reinforced concrete collar 48 inches minimum wide by 6 inches thick with No. 4 reinforcement 12 inches each way and finished flush with grade. Storage tanks shall be installed with antifoatation slab and tie downs in accordance with the manufacturer's instructions. Interceptors shall be installed on redwood sleepers or antifoatation slab in accordance manufacturer's instructions. Both storage

tanks and interceptors shall have compacted pea gravel backfill installed to grade in accordance with the manufacturer's instructions.

3.03 PIPE CLEANOUTS

- A. Cleanouts shall be the same size as the pipe up to and including 4 inches; for 6 inch and larger pipe, cleanouts shall be 4-inch minimum. Cleanouts for drainage pipe shall consist of a longsweep 1/4 bend or one or two 1/8 bends extended to the place indicated. Wall or accessible piping cleanouts shall be T-pattern, 90-degree branch drainage fittings having screw plugs. Cleanouts shall be provided at the base of each riser and shall consist of a wye pattern fitting with a screw plug.

3.04 IDENTIFICATION

- A. Identification shall be as specified in Section 20 40 13 - Identification for Facility Services.

3.05 FIELD QUALITY CONTROL

- A. Do not cover products to be buried and do not paint products or line segments to be painted until those products have been inspected, tested, and accepted.
- B. Test installed sewerage lines and equipment, with the Engineer in attendance, as follows:
1. Fill gravity sewers and soil pipe with water and allow to stand for not less than 30 minutes without leaking; low and intermediate branches shall have been temporarily sealed. Provide test tees having cast iron screwed plugs in the vertical stacks if the sewers and soil pipe are to be tested in sections. Accomplish testing of interior lines before lines are concealed. Repair leaks and retest systems until the system exhibits no leaks. Head of water shall be not less than 5 feet, and shall not exceed 10 feet.
 2. Disconnect force mains from equipment, seal open ends, and fill mains with water, and hydrostatically test to a pressure of 50 psi greater than the normal pumping pressure. Maintain test pressure until the force main system has been examined for leaks. Repair leaks and retest system until no leaks are exhibited. Use testing instruments calibrated by a qualified laboratory in accordance with Section 01 45 00 - Quality Control.
 3. Test equipment by operation and adjustment of controls. Faulty equipment or controls shall be either repaired or replaced.

3.06 PAINTING

- A. Except where indicated, piping systems shall not be painted. Where pipes are indicated to be painted, as exposed piping in finished rooms, prepare pipe and paint in accordance with Section 09 91 00 -Painting.

3.07 CLEANING

- A. Cleaning of installed products shall consist of removing dirt and foreign material from the surfaces of products. Manufacturer's labels shall remain intact. Rust stained products shall either be replaced or recoated with paint, which is compatible with factory-applied coating.

3.08 REPAIR

- A. Repair pipe coatings, which have become damaged during installation of pipe. Rust stained cast iron pipe and fittings shall either be replaced or recoated with paint, which is compatible with factory-applied coating.

END OF SECTION 22 13 01

22 13 16

SANITARY WASTE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 100 psig.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

- C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.

1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.5 SANITARY SOIL, WASTE AND VENT PIPING, WITHIN BUILDING (UNDERGROUND APPLICATION)

- A. PVC Pipe (Below Grade): Schedule 40 PVC, conform to ASTM D-1785 Soil and Waste Vent piping. Fittings shall be compatible material with solvent cement type joints.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311 drain, waste, and vent pipe patterns with solvent-cemented joints.

2.6 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS (ABOVE GROUND APPLICATION)

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
- C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) ANACO.
 - 2) Fernco, Inc.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.

2.7 SPECIAL PIPE FITTINGS

- A. Flexible, Non-pressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Co.
 - 2. Sleeve Materials:
 - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Non-pressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- C. Rigid, Unshielded, Non-pressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. ANACO.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings and solvent stack fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
- C. Aboveground soil and waste piping NPS 6 and larger shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hub less cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hub less-coupling joints.
- D. Aboveground, vent piping NPS 4 and smaller shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
- E. Underground, soil, waste, and vent piping NPS 6 and smaller shall be the following:
 - 1. Cellular-core, Sewer and Drain Series, schedule 40 PVC pipe; PVC socket fittings; and solvent-cemented joints.

3.2 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22.
- B. Basic piping installation requirements are specified in Division 22.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- L. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- M. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Join hub less cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hub less-coupling joints.
- C. PVC Non pressure Piping Joints: Join piping according to ASTM D 2665.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet, if indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
 7. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 8. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 9. Prepare reports for tests and required corrective action.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.

- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.8 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 221316

22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Trench drains.
 - 4. Roof flashing assemblies.
 - 5. Through-penetration fire-stop assemblies.
 - 6. Miscellaneous sanitary drainage piping specialties.
 - 7. Flashing materials.
- B. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Show fabrication and installation details for frost-resistant vent terminals.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.
- D. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.

- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Light Commercial Operation.
 - 2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule heavy-duty, adjustable housing threaded, adjustable housing cleanout.
 - 3. Size: Same as connected branch.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub less, cast-iron soil pipe test tee as required to match connected piping.
5. Size: Same as connected branch.
6. Body: PVC.
7. Closure Plug: PVC.
8. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.5 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASME A112.6.3.
3. Pattern: Sanitary drain.
4. Body Material: Gray iron.

B. Wall Box:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Durgo, Inc.
 - b. Oatey.
 - c. RectorSeal.
 - d. Studor, Inc.
2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.6 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor / Stoneman Div.
 - b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.

3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.7 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Fires top Assemblies:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
 2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
 3. Size: Same as connected soil, waste, or vent stack.
 4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 6. Special Coating: Corrosion resistant on interior of fittings.

2.8 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 2. Size: Same as connected waste piping.
- B. Deep-Seal Traps:
 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Air-Gap Fittings:
 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 2. Body: Bronze or cast iron.
 3. Inlet: Opening in top of body.
 4. Outlet: Larger than inlet.
 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- E. Sleeve Flashing Device:
 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 2. Size: As required for close fit to riser or stack piping.
- F. Stack Flashing Fittings:

1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter flashing.

I. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.9 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz/sq. ft.
 2. Vent Pipe Flashing: 8 oz/sq. ft.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 75 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.
- I. Assemble open drain fittings and install with top of hub 2 inches above floor.
- J. Install deep-seal traps on floor drains and other waste outlets, as required.
- K. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- N. Install vent caps on each vent pipe passing through roof.
- O. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

- P. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- Q. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled Neutralization tanks and their installation, including piping and electrical connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

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COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.2 SUMMARY

- A. This Section includes the following:
- B. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
- G. The following are industry abbreviations for rubber materials:

1.4 SUBMITTALS

- A. Product Data: For the following:
- B. Welding certificates.

- C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- D. Prepare Coordination / Installation Shop drawings to a scale of 1/4"=1'0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 SCOPE OF SERVICES

2.5 APPLICABLE CODES

- A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.
- B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.

- C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
- D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.
- E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.
- F. Contractor will comply will all current (date of permit) City of Houston Building Codes and ordnances for construction.

2.6 DRAWINGS & SPECIFICATIONS

- A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.
- B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.
- C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.
- D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.
- E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution by made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date without fail.
- F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.

- G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.
- H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) and Plumbing Design Documents and all other trades.
- I. Coordinate with Division 1 requirements for substitution, unless noted otherwise the Contractors wishing to substitute products, materials or methods from those indicated or specified, shall submit such requests to the Owner or Engineer in writing and within THIRTY (30) WORKING DAYS OF NOTIFICATION OF CONTRACT AWARD. Requests for permission to utilize alternates or substitutions will not be considered after that time, unless the Specified item is unavailable or will adversely effect to completion of the Project. Claims submitted for consideration will require notarized letters from all parties involved and will be considered only if the Contractor has been timely in his delivery for review of all required equipment and material submittals. Owner or Engineer will investigate such requests for substitution and if acceptable will issue a letter allowing the substitution.
- J. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.
- K. Requests shall be bound and shall consist of three (3) sets of descriptive literature and performance data covering each item of equipment or material. The submittal shall include the following:
 - L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions. The Engineer shall be the sole authority to approve or disapprove any and all substitutions.
- M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

2.7 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 15, indicate the following installed conditions.
- B. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes

made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.

- C. Contractor Startup and Commissioning Verification - the system will provide a secure page for each integrated system allowing the contractor responsible for each phase to sign on and certify the status of each piece of equipment.
- D. Refer to Division 1 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as built prints and re-producible is a condition of final acceptance.
- E. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.
- F. At the Engineer's option, the Contractor shall transfer all data from the record "AS-BUILT" prints to an electronic media such as AutoCAD latest release, in order to plot the reproducible media "AS-BUILT" drawings. Since data stored on electronic media can deteriorate undetected or be modified without the Engineer's knowledge, the AutoCAD electronic drawing files are provided without warranty or obligation on the part of the Engineer as to accuracy or information contained in the files. All information in the files shall be independently verified by the user. Any user shall agree to indemnify and hold the Engineer harmless from any and all claims, damages, losses, and expenses including but not limited to Attorney's fees arising out of the use of the AutoCAD drawing files. Engineer shall furnish to the Contractor electronic media files of Contract Documents for the Contractor to use for inputting of the data from the record "AS-BUILT" prints and the Contractor shall return the revised electronic files on CD ROM properly labeled to the Engineer and shall submit the plotted reproducible drawings and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as described in paragraph F. below.
- G. of the work, the Contractor shall transfer all marks from the submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet.

2.8 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.9 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

- 2. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
 - D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
 - E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
 - F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
 - G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - H. Solvent Cements for Joining Plastic Piping:
 - I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
- 2.10 TRANSITION FITTINGS
- A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Eslon Thermoplastics.
 - B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Thompson Plastics, Inc.
 - C. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. NIBCO INC.
 - 2. NIBCO, Inc.; Chemtrol Div.
- 2.11 DIELECTRIC FITTINGS
- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
 - B. Insulating Material: Suitable for system fluid, pressure, and temperature.
 - C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Capitol Manufacturing Co.
 - 2. Central Plastics Company.
 - 3. Eclipse, Inc.
 - 4. Epco Sales, Inc.
 - 5. Hart Industries, International, Inc.
 - 6. Watts Industries, Inc.; Water Products Div.
 - 7. Zurn Industries, Inc.; Wilkins Div.
 - D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Capitol Manufacturing Co.
2. Central Plastics Company.
3. Epco Sales, Inc.
4. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Central Plastics Company.
4. Pipeline Seal and Insulator, Inc.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Calpico, Inc.
2. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Perfection Corp.
2. Precision Plumbing Products, Inc.
3. Sioux Chief Manufacturing Co., Inc.
4. Victaulic Co. of America.

2.12 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

2.13 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.14 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.15 GROUT & FOUNDATION

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
- B. Foundations and pads shall be constructed of reinforced concrete and shall be sized and reinforced as noted or detailed on the Drawings. As a minimum, pads shall be 6" thick, by width and length as required by item it is under, reinforced with 6 x 6 W2.9 x W2.9 Welded Wire mesh.
- C. Support attachments, unless otherwise noted on shown, shall be securely attached to the items foundation, pad or building structure, per manufacturers recommendations and shall be approved by the Architect.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - 3. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 5. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 6. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - 7. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - 8. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 9. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - 10. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - 11. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - 12. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - 3. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - 4. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 23 05 00

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23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.2 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.3 SCOPE

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for Owner's use.

1.4 WORK SPECIFIED ELSEWHERE

- A. Painting
- B. Automatic temperature controls.
- C. Power control wiring to motors and equipment.

1.5 REFERENCES

- A. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG 1 – Motors and Generators.
- E. ANSI/NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors.
- F. ANSI/NFPA 70 – National Electrical Code, 2017 Edition.

- G. ANSI/UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations.
- H. ANSI/UL 1004 – Electric Motors.
- I. EISA - The Energy Independence & Securities Act 2007.
- J. IECC – International Energy Conservation Code, 2015 edition with City of Yoakum, Texas amendments.
- K. IMC – International Mechanical Code, 2015 edition with City of Yoakum, Texas amendments.

1.6 WARRANTY

- A. Warrant the Work specified herein for one (1) year and motors for five (5) years beginning on date of Substantial Completion against becoming unserviceable or causing an objectionable appearance resulting from either defective or non-conforming materials or workmanship.

1.7 QUALITY ASSURANCE

- A. Motors associated with variable frequency drives (VFD) shall be inverter-duty rated, and provided with grounded shaft or ceramic bearings to insulate shaft, and Class F 105 degrees C rise insulation. Ref. NEMA MG1 Part 31.

1.8 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.
- B. Shop Drawings: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures variations, and accessories.
- D. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.

- a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
 - E. Motor Nameplate Information: Manufacturer's name, address, utility and operating data. Bandwidth: submit bandwidth requirements for all Ethernet connections to the Local Network.
 - F. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.
 - G. Submit manufacturer's installation instructions under provisions of Section 23 05 00. Indicate setting, mechanical connections, lubrication, and wiring instructions.
 - H. Refer to Division 01 for additional requirements.
- 1.9 OPERATION AND MAINTENANCE DATA
- A. Submit operation and maintenance data under provisions of Section 23 05 00.
 - B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.
- 1.10 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three (3) years' documented product development, testing, and manufacturing experience.
- 1.11 REGULATORY REQUIREMENTS
- A. Conform to the National Electrical Code.
- 1.12 DELIVERY, STORAGE AND HANDLING
- A. Delivery: Deliver products to site under provisions of Section 23 05 00. Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.
 - B. Time and Coordination: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
 - C. Storage:
 - 1. Store and protect products under provisions of Section 23 05 00.
 - 2. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof coverings. For extended outdoor storage, remove motors from equipment and store separately.

1.13 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this Section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Electrical Service: Refer to Drawing schedules for required electrical characteristics.
- C. Approved Manufacturers: Provide motors by a single manufacturer as much as possible.
 - 1. Baldor-Reliance.
 - 2. General Electric ES Energy Saver®.
 - 3. Siemens.
 - 4. Marathon® manufactured by Regal-Beloit America, Inc.
 - 5. U.S. Electrical – NEMA Premium Efficiency.

- D. Motor Characteristics
 - 1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
 - 2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- E. General: Comply with NEMA MG 1 unless otherwise indicated.
- F. Temperature Rise: Match insulation rating.
- G. Starting Capability: As required for service indicated five (5) starts minimum per hour.
- H. Phases and Current: Verify electrical service compatibility with motors to be used.
 - 1. Up to 1/2 hp: Provide permanent split, capacitor-start single phase with inherent overload protection.
 - 2. 3/4 hp and larger: Provide NEMA MG 1, Design B, squirrel-cage induction polyphase.
 - 3. Provide two (2) separate windings on 2-speed polyphase motors.
 - 4. Name plate voltage shall be the same as the circuit's normal voltage, serving the motor.
- I. Service Factor: 1.15 for polyphase; 1.35 for single phase.
- J. Starting Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- K. Frames: U-frames 1.5 hp and larger.
- L. Bearings: Provide sealed regreasable, shielded, anti-friction ball bearings; with top mounted Alemite lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:
 - 1. Design for radial and thrust loading where applicable.
 - 2. Permanently Sealed: Where not accessible for greasing.
 - 3. Sleeve-Type with Oil Cups: Light duty fractional horsepower motors or polyphase requiring minimum noise level.
- M. Enclosure Type: Provide enclosures as follows:
 - 1. Concealed Indoor: Open drip proof (ODP).
 - 2. Exposed Indoor: Guarded.
 - 3. Outdoor Typical: Type II, TEFC.
 - 4. Outdoor Weather Protected: Type II, TEFC.
- N. Overload Protection: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.
- O. Noise Rating: "Quiet" except where otherwise indicated.
- P. Efficiency: Provide premium efficient motors as defined in NEMA MG 1 in accordance with minimum full load efficiency listed in the following table, when tested in accordance with IEEE Test Procedure 112A, Method B, including stray load loss measure.
- Q. Thermal Protection:

1. Polyphase Motors: Comply with NEMA MG 1 requirements for thermally protected motors.
2. Single Phase Motors: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

R. Additional Requirements for Polyphase Motors

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers:
 - a. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - b. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - c. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

2.5 MOTOR EFFICIENCIES – NOMINAL, FULL LOAD, THREE PHASE

Motor HP	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7
20	92.4	93.0	92.4	92.4	93.0	92.4
25	93.0	93.6	93.0	93.0	93.6	93.0
30	93.6	94.1	93.0	93.6	93.6	93.0
40	94.1	94.1	93.6	94.1	94.1	93.6
50	94.1	94.5	93.6	94.1	94.5	94.1
60	95.0	95.0	94.1	94.5	95.0	94.1
75	95.0	95.0	94.5	95.0	95.4	94.5
100	95.0	95.4	94.5	95.4	95.4	94.5
125	95.4	95.4	95.0	95.4	95.4	95.0
150	95.8	95.8	95.4	95.8	95.8	95.4
200	95.4	95.8	95.4	95.8	96.2	95.8

2.6 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5 - 150	1.15	1.15	1.15	1.15

2.7 MOTOR CONTROLLERS (STARTERS)

- A. All motor controllers (for equipment furnished under Division 23) shall be furnished under Division 26 and installed under Division 26 unless otherwise noted on the plans.
- B. Motor starters shall be furnished as follows.
 - 1. General: Motor starters shall be Schneider-Electric Class 8536 across-the-line magnetic type, full-voltage, non-reversing (FVNR) starter. All starters shall be constructed and tested in accordance with the latest NEMA standards, sizes and horsepower. IEC sizes are not acceptable. Starters shall be mounted in a general purpose dead front, painted steel enclosure and surface-mounted. Provide size and number of poles as shown and required by equipment served. Provide a two speed, two winding or two speed, single winding motor starter as required for two speed motors.
 - 2. Contacts: Magnetic starters' contacts shall be double break solid silver alloy.
 - 3. All contacts shall be replaceable without removing power wiring or removing starter from panel. The starter shall have straight-through wiring.
 - 4. Operating Coils: Operating coils shall be 120 volts and shall be of molded construction. When the coil fails, the starter shall open and shall not lock in the closed position.
 - 5. Overload Relays: Provide manual reset, trip-free Class 20 overload relays in each phase conductor in of all starters. Overload relays shall be melting alloy type with visual trip indication. All 3 phase and single phase starters shall have one overload relay in each underground conductor. Relay shall not be field adjustable from manual to automatic reset. Provide 6 overload relays for two speed motor starters.
 - 6. Pilot Lights: Provide a red running pilot light for all motor starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter and shall not be wired across the operating coil.
 - 7. Controls: Provide starters with HAND-OFF-AUTOMATIC switches. Coordinate additional motor starter controls with the requirements of Division 23. Motor starter controls shall be mounted in the starter enclosure cover.
 - 8. Control Power Transformer: Provide a single-phase 480 volt control power transformer with each starter for 120 volt control power. Connect the primary side to the line side of the motor starter. The primary side shall be protected by a fuse for each conductor. The secondary side shall have one (1) leg fused and one (1) leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.
 - 9. Auxiliary Contacts: Each starter shall have one (1) normally open and one (1) normally closed convertible auxiliary contact in addition to the number of contacts required for the "holding interlock", remote monitoring, and control wiring. In addition, it shall be possible to field-install three more additional auxiliary contacts without removing existing wiring or removing the starter from its enclosure.
 - 10. Unit Wiring: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for line and load power wiring and HVAC control wiring.

11. Enclosures: All motor starter enclosures shall be NEMA 1, general purpose enclosures or NEMA 3R if mounted exposed to high moisture conditions. Provide NEMA 4X when located near cooling towers.
 12. Power Monitor: Provide a Macromatic PMPU phase failure and under-voltage relay, base and wiring required for starters serving motors 10 horsepower and larger. Set the under-voltage setting according to minimum voltage required for the motor to operate within its range.
- C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturer's.
1. ABB
 2. Danfoss
 3. Yaskawa

2.8 COMBINATION MOTOR STARTERS

- A. General: Combination motor starters shall consist of a magnetic starter and a fusible or non-fusible disconnect switch in a dead front, painted steel NEMA 1 enclosure unless otherwise noted and shall be surface-mounted. Size and number of poles shall as shown and required by equipment served. Combination motor starters shall be as specified for motor starters in Paragraph 2.4.B, except as modified herein.
- B. Disconnect Switch: Disconnect switches shall be as specified in Division 26.
- C. Approved Manufacturers: Controller numbers are based on first named manufacturer. Provide one of the following manufacturer's.
1. Siemens.
 2. Schneider Electric.
 3. ABB.

2.9 VARIABLE FREQUENCY DRIVES

- A. Manufacturers
1. General:
 - a. All products provided under this section shall either be Pre-certified or certified prior to bid as described below. If for any reason the product listed is not appropriate to fully meet the project requirements, alternate products shall be certified and bid as described below.
 - b. Acceptable Manufacturers
 - 1) ABB
 - 2) Danfoss
 - 3) Yaskawa
 2. Additional Product Certification: In the event that additional or alternate products from the listed Manufacturer of the Pre-Certified product line listed above are needed to accomplish the requirements of this project, additional products and applications shall be certified following the procedures and requirements of the certification specifications.
 - a. Any product that is not certified will not be accepted.
 - b. Upon satisfactory completion of the certification, a registration number will be issued for each product.
 - c. Include the registration number for each product in the submittal
 - d. The Owner reserves the right to accept or reject any products at their sole discretion as deemed in their best interest.
- B. Where shown on the Drawings, adjustable frequency drives shall have the following features:

1. The VFD shall be rated for 480 VAC (optional input voltages of 208-240 VAC). The VFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 40°C ambient and 5 kHz switching frequency continuous and utilize dynamic noise control for motors.
2. The VFDs shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFDs are not acceptable. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section. Bipolar Junction Transistors, GTOs or SCRs are not acceptable. The VFDs shall run at the above listed switching frequencies.
3. The VFD's shall have efficiency at full load and speed that exceeds 95% for VFDs below 15 Hp and 97% for drives 15 Hp and above. The efficiency shall exceed 90% at 50% speed and load.
4. The VFDs shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
5. The VFDs shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250% for constant torque drives. The VFDs shall have a one (1) minute overload current rating of 110% for variable torque drives.
6. The VFDs shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
7. The VFD's shall have an integral EMI/RFI filter as standard.
8. The VFD's shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519-2014 for general systems applications, by utilizing the standard 5% nominal impedance integral AC three-phase line reactor.
9. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.
10. Total harmonic distortion shall be calculated under worst-case conditions in accordance with the procedure outlined in IEEE standard 519-2014. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.
11. The system containing the VFDs shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-2014. If the system cannot meet the harmonic levels with the VFDs provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply either a 12-Pulse or an 18-pulse, multiple bridge rectifier ac to dc conversion section with phase shifting transformer or Matrix topology solution for all drives 50 Hp and above. This 18-pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine-wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not acceptable for drives 50 Hp and above.
12. The VFD's shall be able to start into a spinning motor. The VFDs shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFDs shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Standard operating conditions shall be:
 - a. Incoming Power: Three-phase, 208 - 240 / 380 - 500 / 525 - 690 Vac (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
 - b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
 - c. Speed regulation of +/- 0.5% of base speed.

- d. Load inertia dependent carryover (ride-through) during utility loss.
 - e. Insensitive to input line rotation.
 - f. Power loss ride through shall be adjustable through 2 seconds.
 - g. Humidity: 0 to 95% (non-condensing and non-corrosive).
 - h. Altitude: 0 to 3,300 feet above sea level.
 - i. Ambient Temperature: -10 to 50°C (CT), -10 to 40°C (VT).
 - j. Storage Temperature: -40 to 60°C.
14. Control Functions
- a. VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFDs shall have a 5 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
 - b. The keypad shall include a Local/Remote pushbutton selection. Both start/ stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.
 - c. The keypad shall have copy / paste capability.
 - d. Upon initial power up of the VFD, the keypad shall display a startup guide that will sequence all the necessary parameter adjustments for general start up.
 - e. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition, the software shall permit control and monitoring via the VFD's RS232 port. The manufacturer shall supply free website download for the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this Section.
 - f. The operator shall be able to scroll through the keypad menu to choose between the following:
 - 1) Monitor
 - 2) Operate
 - 3) Parameter setup
 - 4) Display parameter values
 - 5) Display current faults
 - 6) Fault history
 - 7) Keypad LCD contrast adjustment
 - 8) Information to indicate the standard software and optional features software loaded.
 - g. The following setups and adjustments, at a minimum, are to be available:
 - 1) Start command from keypad, remote or communications port
 - 2) Speed command from keypad, remote or communications port
 - 3) Motor direction selection
 - 4) Maximum and minimum speed limits
 - 5) Acceleration and deceleration times, two settable ranges
 - 6) Critical (skip) frequency avoidance
 - 7) Torque limit
 - 8) Multiple attempt restart function
 - 9) Multiple preset speeds adjustment
 - 10) Parameter for speed search to catch a spinning motor start or normal start selection
 - 11) Programmable analog output
 - 12) DC brake current magnitude and time
 - 13) PI process controller
15. The VFDs shall have the following system interfaces:

-
- a. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and shall be provided with the following available as a minimum:
 - 1) Remote manual/auto
 - 2) Remote start/stop
 - 3) Remote forward/reverse
 - 4) Remote preset speeds
 - 5) Remote external trip
 - 6) Remote fault reset
 - 7) Process control speed reference interface, 4-20 mA dc
 - 8) Potentiometer and 1-10 Vdc speed reference interface
 - 9) RS232 programming and operation interface port
 - b. Provide a communications interface with all points and functions listed in this section connected to the BMS provided. A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
 - 1) Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
 - a) Fault
 - b) Run
 - c) Ready
 - d) Reversed
 - e) Jogging
 - f) At speed
 - g) Torque Limit Supervision
 - h) Motor rotation direction opposite of commanded
 - i) Over temperature
 - 2) Programmable open collector output with available 24Vdc power supply and selectable with the following available at minimum:
 - a) Fault
 - b) Run
 - c) Ready
 - d) Reversed
 - e) Jogging
 - f) At speed
 - g) Torque Limit Supervision
 - h) Motor rotation direction opposite of commanded
 - i) Over temperature
 - 3) Programmable analog output signal, selectable with the following available at minimum:
 - a) Motor current
 - b) Output frequency
 - c) Frequency reference
 - d) Motor speed
 - e) Motor torque
 - f) Motor power
 - g) Motor voltage
 - h) DC-bus voltage
16. Monitoring and Displays
- a. The VFD's display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
 - 1) Run
 - 2) Forward
 - 3) Reverse
 - 4) Stop

- 5) Ready
 - 6) Alarm
 - 7) Fault
 - 8) I/O terminal
 - 9) Keypad
 - 10) Bus/Comm
 - 11) Local / Remote (LED)
 - 12) Fault)
- b. The VFD's keypad shall be capable of displaying the following monitoring functions at a minimum:
- 1) Output frequency
 - 2) Frequency reference
 - 3) Motor speed
 - 4) Motor current
 - 5) Motor torque
 - 6) Motor power
 - 7) Motor voltage
 - 8) DC-bus voltage
 - 9) Unit temperature
 - 10) Voltage level of analog input
 - 11) Current level of analog input
 - 12) Digital inputs status
 - 13) Digital and relay outputs status
 - 14) Analog out
17. Protective Functions
- a. The VFD shall include the following protective features at minimum:
- 1) Over current
 - 2) Overvoltage
 - 3) Inverter fault
 - 4) Under voltage
 - 5) Input phase loss
 - 6) Output phase loss
 - 7) Under temperature
 - 8) Over temperature
 - 9) Motor stalled
 - 10) Motor under load
 - 11) Logic voltage failure
 - 12) Microprocessor failure
- b. The VFD shall provide ground fault protection during power-up, starting, and running. VFD's with no ground fault protection during running are not acceptable.
18. Diagnostic Features
- a. Ten (10) faults History
 - b. Record and log faults
19. Indicate the most recent first, and store up to ten (10) faults.
20. Additional features that must be included in the VFD:
- a. Thermal or magnetic only circuit breaker to provide a disconnect means. Operating handle shall protrude the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. This shall be defeat able by maintenance personnel.
- b. Three (3) contactor bypass shall include a drive input disconnect, an VFD input isolation contactor, bypass contactor and an VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit

shall include control logic, status lights and motor over current relays. The complete bypass system (Inverter-Off-Bypass) (Hand-Off-Auto with Inverter-Bypass) selector switch(s), and inverter/bypass pilot lights shall be packaged with the VFD. The unit may be set up for (Manual or Automatic) bypass operation upon an VFD trip.

- c. Fused space heaters with thermostat for oversize enclosures to minimize condensation potential upon drive shutdown.
 - d. Motor over-current relay to provide motor over current sensing of a given level of load current.
 - e. Motor filter for use on motor cable runs exceeding 100 feet for motors with a peak voltage insulation rating less than 1600 Vac. Motors without NEMA MG1, Part 31 construction shall be identified to bidders.
 - 1) The dV/dt filter shall be located at the VFD and shall reduce the dV/dt clamp any voltage overshoots of the VFD output. It will return the energy in the voltage overshoots to the VFD's dc bus. A power dissipative resistance device is not acceptable. Filter shall be a Eaton MotoR_x™ series.
21. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
 2. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
 3. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.2 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD's on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependent adjustments, communications setup and verification of proper VFD operation.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.
 1. Inspection and final adjustments.
 2. Operational and functional checks of VFDs and spare parts.
 3. Provide cable and connector to the IP drop supplied by Controls Contractor.
 4. Verify that the unit is properly configured for remote communication to the system.
 5. The Contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.

- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.3 MAINTNANCE / WARRANTY SERVICE

- A. Warranty to commence twelve (12) months from the date of start-up, not to exceed 36 months from the date of shipment, and include all parts, labor, and travel time.

3.4 FIELD TESTING

- A. The VFD manufacturer shall perform harmonic measurements at the point where the utility feeds multiple customers (PCC) to verify compliance with IEEE 519-2014. A report of the voltage THD and current TDD shall be sent to the engineer. The Contractor shall provide labor, material, and protection as needed to access the test points. The readings shall be taken with all drives and all other loads at full load, or as close as field conditions allow.

3.5 TRAINING

- A. The Contractor shall provide a training session for up to two (2) Owner's representatives for one (1) workday with a maximum of two (2) trips at a job site location determined by the Owner. Training and instruction time shall be in addition to that required for start-up service.
- B. The training shall be conducted by the manufacturer's qualified representative.
- C. The training program shall consist of the following:
 1. Instructions on the proper operation of the equipment.
 2. Instructions on the proper maintenance of the equipment.

END OF SECTION 230513

23 05 29

SLEEVES, FLASHINGS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install supports, anchors and sleeves applicable to mechanical, plumbing, and fire protection systems, including:
 - 1. Pipe, duct, and equipment hangers, supports, and associated anchors.
 - 2. Equipment bases and supports.
 - 3. Sleeves and seals.
 - 4. Flashing and sealing equipment and pipe stacks.

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Provide hanger and support inserts and sleeves and coordinate placement into formwork.

1.3 RELATED SECTIONS

- A. Section 230700 – HVAC Insulation.
- B. Section 230716 – HVAC Equipment Insulation.
- C. Section 013300 Submittals.
- D. Section 01524 Construction Waste Management
- E. Section 01352 LEED Requirements
- F. Section 01611 Environmental Management
- G. Section 01570 Pollution Prevention and Control

1.4 SUBMITTALS

- A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and

- chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
- b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. Grinnell
- B. Kindrof

- C. Unistrut
- D. Specified Technologies, Inc.
- E. B-line
- F. Power Strut

2.5 PIPE HANGERS AND SUPPORTS

- A. Hangers for Non-Insulated Pipe Sizes 1/2 to 4-Inch: Provide malleable iron, adjustable swivel, split ring.
- B. Hangers for Insulated Pipe Sizes 1/2 to 3 Inches and Non-Insulated Pipe Sizes 6 Inches and Over: Galvanized carbon steel, adjustable, clevis.
- C. Supports for Single Hot Pipe Sizes 4 Inches and Over and Cold Pipe Sizes 4 Inches and Over; Carbon Steel Roller.
- D. Multiple or Trapeze Hangers: Galvanized steel channels with welded spacers and hangers rods, cast iron roll and stand for sizes 4 inches and larger hot water piping and 4 inches and larger chilled water piping.
- E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- F. Wall Support for Pipe Sizes to 4 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support for Pipe Sizes 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- I. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- J. Design hangers without disengagement of supported pipe.
- K. Copper Pipe Support and Hangers: Carbon steel ring, adjustable, copper plated.
- L. Shield for Insulated Piping 2 Inches and Smaller: 18 gauge galvanized steel shield over insulation in 180-degree segments, minimum 12 inches long at pipe support.
- M. Shield for Insulated Piping 2-1/2 Inch and Larger (Except Cold Water Piping): Use pipe support inserts.

Galvanized steel shields in 180-degree segments in accordance with following table:

Pipe	Metal Gauge	Shield Length
2 1/2" to 5"	15	12"

6" to 12"	14	24"
Over 12"	12	24"

2.6 HANGER RODS

- A. Steel, threaded on both ends or one on one end or continuous threaded. Galvanized or cadmium plated.

2.7 INSERTS

- A. Provide malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms, size inserts to suit threaded hanger rods.

2.8 FLASHING

- A. Metal Flashing: 26 gauge galvanized steel.
- B. Flexible Flashing: 47 mil thick sheet butyl: compatible with roofing.
- C. Caps: Steel, 22 gauge minimum; use 16 gauge at fire resistant elements.

2.9 EQUIPMENT BASE AND SUPPORTS

- A. Provide 6" concrete pads and equipment bases for all outdoor equipment on grade, floor mounted equipment in main central plant area, areas with floor below grade, penthouse equipment rooms, floor mounted air handling units and where shown on Drawings.
- B. Provide prefabricated curbs or roof mounted equipment with the equipment. Equipment curb must compensate for slopped roof deck as required to set equipment level.

2.10 SLEEVES

- A. Sleeves for Pipes through Non-fire Rated Floors: Form with 16 gauge galvanized steel.
- B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Above Grade: Form with 18 gauge galvanized steel.
- C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Provide prefabricated fire rated sleeves including seals, UL listed; or provide Schedule 40 galvanized steel, sized for minimum 1 inch space between sleeve and carrier pipe.
- D. Sleeves for Pipe through Floor Supporting Riser Piping: Standard weight galvanized steel pipe.
- E. Sleeves for Pipes through Roof: Standard weight galvanized steel pipe.
- F. Sleeves for Round Ductwork: Form with galvanized steel.
- G. Sleeves for Rectangular Ductwork: Form with galvanized steel.
- H. Provide fire-stop compound at all penetrations of floor slabs or firewalls such that fire rating integrity of barrier is not lessened.

- I. Caulk: Caulk all sleeves water and airtight.
- J. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping. Provide pipe sleeves one size larger than the pipe it serves, including insulation, except where "Link Seal" casing seals are used.
- K. Sleeves Penetration Walls Below Grade: Provide "Link-Seal" and sleeve as manufactured by Thunderline Corporation, Wayne, Michigan, for all pipes passing through walls below grade.

2.11 FINISHES

- A. Prime coat and paint exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- B. Provide galvanized hangers and supports for all piping and ductwork located in crawlspace, pipe shafts, and above suspended ceiling spaces.
- C. Provide hanger rods, bolts, nuts, and all metal parts coated with the same material as hangers.

2.12 ANCHOR BOLTS

- A. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the manufacturer of the equipment.

PART 3 - EXECUTION

3.1 PIPE HANGERS AND SUPPORTS

- A. Support horizontal pipes as follows:

Pipe Size	Max. Hanger Spacing*	Hanger Diameter
1/2 to 1-1/4 inch	6'-0"	3/8"
1-1/2 to 2 inch	8'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
4 to 6 inch	10'-0"	5/8"
8 to 12 inch	10'-0"	7/8"
14 inch and Over	14'-0"	1"
C.I. Bell and Spigot (or No-Hug)	5'-0" and at Joints	

*Comply with NFPA 13 for fire protection pipe hanger spacing.

** For PVC and Cast Iron pipes maximum hanger spacing shall not exceed 4 feet with 3/8" hanger rod and 5 feet with 5/8" hanger rod respectively.

- B. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between fingers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide corrosion resistant hangers by Corr-Tech for all piping hangers in corrosive areas. Provide hanger rods, bolts, nuts and all metal parts coated with the same material as hangers.

3.2 LOW PRESSURE DUCT SUPPORT SCHEDULE

- A. All horizontal ducts up to and including 40 inches in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets, or clamps and fastened to above inserts with toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8' 0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.
- B. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one pair of supports 8' 0" on centers according to the following:

<u>Angle</u> <u>Length</u>	<u>Angle</u>	<u>Rod Diameter</u>
4' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8' 0"	2" x 2" x 1/8"	5/16"
10' 0"	3" x 3" x 1/8"	3/8"

- C. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60." Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

3.3 MEDIUM PRESSURE DUCT SUPPORT SCHEDULE

- A. All horizontal rectangular ducts shall have duct hanger requirements as follows:
 Minimum Hanger Size

Max. Duct	Steel	Galv. Steel	Max.	Min.#
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<u>Dimen.</u>	<u>Rod</u>	<u>Strap Width</u>	<u>Spacing</u>	<u>Hngrs</u>	<u>Trapeze Size</u>
0 through 18"	--	1" x 16 ga.	10'	2	--
19" through 36"	--	1" x 16 ga.	10'	2	--
37" through 60"	3/8"	1" x 16 ga.	8'	2	2" x 2" x 1/4"
61" through 120"	3/8"	1-1/2" x 12 ga.	8'	2	2" x 2" x 1/4"
121" through 240"	3/8"	--	4'	3	2-1/2" x 2-1/2" x 3/16"

- B. All horizontal round ducts shall have ducts hangers spaced 10' 0" maximum with requirements as follows:

<u>Duct Diameter</u>	<u>Min. Hanger Size</u>	<u>No. Hangers</u>	<u>Hanger Ring Size</u>
Up through 18"	1" x 16 gauge	1	1" x 16 ga.
19" to 36"	1" x 12 gauge	1	1" X 12 ga.
37" to 50"	1-1/2" x 12 gauge	1	1-1/2" x 12 ga.
51" to 84"	1-1/2" x 12 gauge	2	Support Bracing Angle

3.4 INSERTS

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- D. Where concrete slabs form finished ceiling, provide inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.5 FLASHING

- A. Provide flexible flashing and metal counter-flashing where sleeves, piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flexible sheet flash and counter-flash all curbs for mechanical equipment on roof with sheet metal; seal watertight.

3.6 EQUIPMENT BASES AND SUPPORTS

- A. Coordinate installation of equipment bases of concrete type specified for all outdoor equipment on grade and floor mounted equipment in main central plant area, areas with floors below grade, penthouse equipment rooms floor mounted air handling units and where shown on drawings.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment
- C. Construct support of steel members. Brace and fasten with flanges bolted to structure.

- D. Provide rigid anchors for pipes after vibration isolation components are installed.
- E. Provide base of a minimum height of 4 inches above finished grade and a width that projects a minimum of 3 inches beyond equipment on all sides. Bevel edges of base.
- F. Prepare surface under bases by cleaning, clearing, chipping and roughing.
- G. Provide curbs of 14 inches minimum height above roofing surface for installation of mechanical equipment on roof.

3.7 CONCRETE FOUNDATIONS ("HOUSEKEEPING PADS")

- A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

3.8 WALL, FLOOR AND CEILING PLATES

- A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

3.9 SLEEVES

- A. Provide sleeves for all pipe penetrations through walls, roof or slab above grade.
- B. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- C. Extend sleeves through floors 2 inches above finished floor level. Caulk sleeves full depth and provide floor plate.
- D. Where piping or ductwork penetrates floor, ceiling wall, close off space between pipe or duct and adjacent work with fire stopping insulation and seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration. When penetration is through a fire rated floor or wall, provide fire safe insulation so that the assembly, when complete, is UL listed and equals the fire rating of construction penetrated by the sleeve.
- E. Install chrome plated steel escutcheons at finished surfaces.

- F. Provide three 6 inch long reinforcing rods welded at 120-degree spacing to the sleeve on all sleeves supporting riser piping 4 inches and larger. Embed reinforcing rods in concrete or grout to existing concrete.
- G. Install sleeve assembly for walls below grade with 1/4-inch thick plate located in the middle of the wall.
- H. Neatly cut hose in existing walls, floors and roofs for placement of sleeves. Place sleeve and grout, and caulk annular space to provide finished appearance.
- I. Install pipe in sleeve so that neither the pipe nor its insulation touches the sleeve at any point.
- J. Seal space between pipe and sleeve watertight for all sleeves penetrating the roof.

3.10 SLEEVES

- A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.
 - 1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.
 - 2. Sleeves through interior walls to be galvanized sheet metal with gauge as required by wall fire rating, 20 gauge minimum.
- B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link-seal closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.
- C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.
- D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.
- E. Vermin proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.
- F. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

- G. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.
- H. Fireproofing: Seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2000° F for two hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be silicone RTV foam or an approved equal. For dry locations, premixed putty equal to Nelson Flameseal Firestop putty may be used.

3.11 ANCHOR BOLTS

- A. Locate position of anchor bolts by means of suitable templates.
- B. When equipment is placed on vibration isolators, secure equipment to the isolator and the isolator to the floor, pad or support as recommended by the vibration isolator manufacturer.

3.12 INSULATION SHIELDS

- A. Provide insulation shields at every hanger support.
- A. Provide shields of the proper length to distribute weight evenly and to prevent sagging or indentation of insulation at hanger.
- B. Install shield so that hanger is placed at the center of the shield.
- B. Attach shield to insulation with adhesive to prevent slippage or movement.
- C. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.
- D. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.
- E. The supports, hangers, anchors, and guides for the chilled water supply and return piping, steam piping, condensate return piping, etc. of the Campus Loop System routed through utility tunnels and below buildings shall be provided as indicated on the Drawings.
- F. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.
- G. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
- H. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.
- I. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

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- J. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.
- K. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
- L. K. Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Grinnell Fig. CT-99c, adjustable, copper plated, tubing ring. Hangers supporting and contacting brass or copper lines 4" and larger shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Grinnell Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.
- M. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8" diameter pipe or smaller in size and supporting all ferrous lines 6" and smaller in size shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.
- N. Hangers supporting and contacting ferrous lines larger than 6" in size and outside of insulation on lines with the outside diameter equivalent to 10" diameter pipe shall be Grinnell Fig. 260, adjustable clevis, with a nut shields as specified in Section 23 07 19 - PIPING INSULATION. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.
- O. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Grinnell Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor. Two-hole rigid pipe clamps at 4 ft. o.c. or Kindorf channels and Grinnell Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. When piping is subject to expansion and contraction, provide spring isolators (see Section 23 05 48 - Vibration Isolation). Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.
- P. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use a Grinnell No. 595 Socket Clamp with Grinnell No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.
- Q. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or

horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

- R. All electrical conduits shall be run parallel or perpendicular to adjacent building lines. Single conduits running horizontally shall be supported by "Caddy" or "Minerallac" type hangers from adequately sized rods (minimum 1/4") from the building structure. Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips". All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers above and below the hanger on the support rod.
- S. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.
- T. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support
- U. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8' centers. Where feasible, conduits may be fastened to the concrete by one hole straps thoroughly anchored to the concrete in an approved manner. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above ceiling equipment, and to support it from touching the ceiling system. Conduit shall be located so as not to inhibit removal of ceiling tiles.

END OF SECTION 23 05 29

23 05 48

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install vibration isolators for rotary, dynamic, or reciprocating equipment or components; include:
 - 1. Inertia bases
 - 2. Vibration isolation

1.2 RELATED SECTIONS:

- A. Section 013300 Submittals.
- A. Section 01524 Construction Waste Management
- B. Section 01352 LEED Requirements
- C. Section 01611 Environmental Management
- D. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- B. ASHRAE – Guide to average Noise Criteria Curves
- A. Local codes and ordinances
- B. Special conditions

1.4 SUBMITTALS

- C. Indicate isolation base dimensions.
- A. Indicate vibration isolator locations, with static and dynamic load.
- B. Include calculation required to certify compliance with specified requirements.
- C. Submit manufacturer's certificate that isolators are properly installed and properly adjusted to meet or exceed specified requirements.
- D. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.

3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- D. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.
- A. Provide vibration isolation devices, including auxiliary steel bases and pouring forms, from a single manufacturer or supplier who will be responsible for complete coordination of all phase of this work.

1.6 INTENT OF RESPONSIBILITY

- A. It is the intent of this specification to provide for vibration isolation supports for all equipment, piping, and ductwork as set out below. The transmission of perceptible vibration, structural borne noise, or objectionable air borne noise to occupied areas by equipment installed under this contract will not be permitted. The Contractor shall be held responsible for installing the vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria, and one which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.
- A. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Concrete housekeeping pads and inertia bases shall be included as part of mechanical work. Pads under electrical gear shall be included as part of electrical work. The concrete work shall meet the requirements specified in the General Contract Specifications.
- B. The Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.

- C. The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the isolation manufacturer or his qualified representative, in company with the Architect or his designated representative, shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.
- D. Vibration isolation devices shall be as manufactured by Amber/Booth Company, Consolidated Kinetics, Korfund Dynamics Corporation, or approved equal.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. Amber-Booth Company
- A. Mason Industries, Inc.

- B. Noise Control, Inc.

2.5 GENERAL DESIGN FEATURES

- A. Provide vibration isolation for all mechanical equipment. Provide inertia bases for all equipment mounted on upper floors.
- A. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.
- B. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cad-plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.
- C. All isolators exposed to the weather shall have steel parts PVC coated, hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.
- D. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.
- E. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.
- F. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".
- G. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.
- H. Isolators for equipment installed out-of-doors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 PSF (pounds per square foot) applied to any exposed surface of the equipment without failure.

2.6 ISOLATION BASES

- A. Type A: Integral structural steel fan and motor base with motor slide rails.
- A. Type B: Slung structural steel base with gusseted brackets.
- B. Type C: Reinforced 3,000 psi concrete set in full depth perimeter structural steel channel frame, with gusseted brackets and anchor bolts.
- C. Type D: Reinforced 3,000 psi concrete base with chamfered edges without channel frame.

- 2.7 BASE TYPES: BASE TYPES AND REQUIRED DEFLECTIONS ARE SPECIFIED UNDER "SCHEDULE OF ISOLATED EQUIPMENT," PARAGRAPH 7.8, OR ARE INDICATED ON THE DRAWINGS. THE BASES SHALL COMPLY WITH THE FOLLOWING DESCRIPTIONS FOR EACH TYPE REQUIRED ON THE PROJECT.
- A. Type B-1 - A structural steel fan and motor base with motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive, and specifically shall be sized to limit deflection of the beam on the drive side to 0.05" due to starting torque. Snubbers to prevent excessive motion on starting or stopping shall be furnished, if required; however, the snubbers shall not be engaged under steady running conditions.
 - A. Type B-2 - A concrete inertia base, consisting of a perimeter steel pouring forming, reinforcing bars welded in place, bolting templates, anchor bolts, and height saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6" deep. The inertia base for pumps shall be at least equal in weight to the pump with its driving motor and be sized for a minimum overlap of 4" around the base of the equipment. Concrete inertia bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split case pumps. The bases shall be T-shaped where necessary to conserve space.
- 2.8 VIBRATION ISOLATORS
- A. Type 1 - An adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring(s) shall be rigidly attached to the mounting base plate and to the spring compression plate. The isolator shall be designed for a minimum K_x/K_y (horizontal to vertical spring rate) of 1.0. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate. Base plates shall be sized to limit pad loading to 100 psi.
 - A. Type 2 - An aluminum-housed, or cast iron housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Sheet or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate.
 - B. Type 3 - An elastomeric mounting having steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric materials. The elastomer may be Neoprene or high synthetic rubber with anti-ozone and anti-oxidant additives. Mountings shall be designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.
 - C. Type 4 - A pad-type mounting consisting of two layers of 3/8" thick, ribbed or waffled, Neoprene pads bonded to a 16 gauge galvanized steel separator plate. Bolting not required. Pads shall be sized for approximately 20 to 40 psi load, or a deflection of 0.10" to 0.16".
 - D. Type 5 - A spring hanger consisting of a rectangular steel box, coil springs, spring cups, Neoprene impregnated fabric washer, steel washer, and Neoprene insert designed to prevent metal to metal contact between the hanger rod and bottom of the hanger box. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.
 - E. Type 6 - A spring hanger, as described in Type 5, with the addition of an elastomeric element at the top of the box for acoustic isolation. The design shall be such to prevent metal - to metal

contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type 3 mountings.

- F. Type 7 - An elastomeric hanger, consisting of a rectangular steel box and an elastomeric isolation element, which shall be of Neoprene or high quality synthetic rubber with anti-ozone and anti-oxidant additive. The elements shall be so designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the element. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the steel box.

2.9 FABRICATION

- A. Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.
- A. Color code spring mounts.
- B. Select spring to operate at two-thirds maximum compression strain, with 1/4 inch ribbed neoprene pads.
- C. Type 1 Isolators: Fabricate with cast aluminum or hot-dipped galvanized steel housing with PVC coated steel spring and neoprene pad bonded to base plate.

2.10 VIBRATION ISOLATION ROOF CURBS FOR ROOF MOUNTED UNITS

- A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support roof-mounted equipment and to withstand 125-mph wind impinging laterally against the side of the equipment.
1. Components: Upper support frame; lower support assembly; freestanding, un-housed, laterally stable steel springs; vertical and horizontal restraints.
 2. Lower Support Assembly: Provide a means of attachment to the building structure and include a wood nailer stripe for attachment of roof material and 2 inches of rigid insulation on the inside of the assembly.
 3. Spring Isolators: As indicated or scheduled. Include adjustment bolt to permit leveling of equipment after installation. Attach to lower assembly with a rubber isolation pad. Locate spring isolators so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 4. Water Seal: Elastomeric seal conforming to UL Class A roofing materials, attached to the upper support frame, extending down past the wood nailer of the lower support assembly, and counter flashed over the roof materials.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install vibration isolators for motor driven equipment.
- A. Set steel bases for 1 inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch clearance. Adjust equipment level.
- B. Provide spring isolators on piping connected to isolated equipment as follows:
- Up to 4 inch diameter, first three points of support; five to 8 inch diameter, first four points of support;

- 10 inch diameter and over, first six points of support. Static deflection of first point to be twice deflection of isolated equipment.

C. Provide minimum of four hangers for each fan coil unit and fan powered terminal units. Provide isolators for each hanger.

3. 2 SCHEDULE

Isolated Equipment	Base Type	Isolator Type
Air Handling Units Floor Mounted	B-1	1
Centrifugal Fans Class I & II to 54 inches Class I & II over 60 inches Class III	B-1 B-2 B-2	1 1 1
Chillers (Grade mounted) Roof mounted AHU	Concrete Pad	4
Other than Slab on Grade	B-2	1
Pumps 3 hp & Smaller 5 hp & Over	B-1 B-2	7 2
Piping		5
Isolated Equipment	Base Type	Isolator Type
Ductwork		N/A
Fan Powered Terminal Units		6
Fan Coil Units		6

END OF SECTION 23 05 48

23 05 53

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install materials for identification of mechanical products installed under Division 22 and 23.

1.2 RELATED SECTIONS

- A. Section 090190 – Maintenance of Painting and Coatings.
- B. Section 013300 Submittals.
- C. Section 01524 Construction Waste Management
- D. Section 01352 LEED Requirements
- E. Section 01611 Environmental Management
- F. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- A. ANSA A 13.1 – Scheme for the Identification of Piping Systems.
- B. NFPA 90A – Installation of air conditioning and Ventilating Systems.

1.4 SUBMITTALS

- A. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

- A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.

- b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
- c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
- 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
- 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
- 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2.1 MANUFACTURERS

- B. W.H. Brady Company
- C. Marken Corporation
- D. Seton Name Plate Company

2.2 MATERIALS

- A. Color: Meet requirements of ANSI A13.1, unless specified otherwise.
- E. Plastic Nameplates: Laminated three-layer plastic with engraved white letters on a black background; minimum size 3 inches long and 1 inch high. Minimum lettering height for numbers and names is 1/4-inch and other data is 1/8-inch.
- F. Metal Tags: Brass with stamped letters: tag size if minimum of 1-1/2 inch diameter with smooth edges.
- G. Stencils: With clean cut symbols and letters 2-1/2 inch high for ductwork and equipment
- H. Stencil Paint: Semi-gloss, high built epoxy esther or alkyd paint.
- I. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering, minimum information indicating flow direction arrow and fluid being conveyed.
- J. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- K. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, manufactured for direct burial service.
- L. Paint:
 - 1. Material Capability: Provide primers, undercoat, finish coat, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.
 - 2. Material Quality:
 - a. Provide the manufacturer's highest-quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

- b. Use of manufacturer=s proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish the manufacturer's material data and certificates of performance for proposed situations.
- c. Provide primer and undercoat materials with a minimum six month guaranteed life against fade and/or color bleed-through.
3. Colors: Provide color samples to the Architect/Engineer for selection form the manufacturer's full range of standard colors.
4. Primers: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated. Subject to compliance with requirements, prime coat materials that may be incorporated in the Work include, but are not limited to the following:
 - a. Galvanized Metal Primers:
 - 1) Devoe: 13201 Mirrorlac Galvanized Metal Primer.
 - 2) Gidden: 5229 Glid-Guard All-Purpose Metal Pirmer.
 - 3) Moore: IornClad Galvanized Metal Latex Pirmer #155.
 - b. Ferrous Metal Primers
 - 1) Devoe: 14920 Bar-Ox Quick Dry Metal Primer, Red.
 - 2) Gidden: 5210 Glid-Guard Universal Fast-Dry Metal Primer.
 - 3) Moore: IornClad Retardo Rust-Inhibitive Paint #163.
5. Undercoat Materials: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated. Subject to compliance with requirements, prime coat materials that may be incorporated in the Work include, but are not limited to the following:
 - a. Galvanized Metal Primers:
 - 1) Devoe: 8801 Velour Alkyd Enamel Undercoat.
 - 2) Gidden: 4200 Spred Ultra Semi-Gloss Enamel.
 - 3) Moore: Moore's Alkyd Enamel Underbody #217.
 - b. Ferrous Metal Primers
 - 1) Devoe: 8801 Velour Alkyd Enamel Undercoat.
 - 2) Gidden: 4200 Spred Ultra Semi-Gloss Enamel.
 - 3) Moore: Moore's Alkyd Enamel Underbody #217.
6. Finish Paint: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated. Subject to compliance with requirements, prime coat materials that may be incorporated in the Work include, but are not limited to the following:
 - a. Galvanized Metal Primers:
 - 1) Devoe: 26XX Velour Alkyd Semi-Gloss Enamel.
 - 2) Gidden: 4200 Spred Ultra Semi-Gloss Enamel.
 - 3) Moore: Moore's Sating Impervo Enamel #235.
 - b. Ferrous Metal Primers
 - 1) Devoe: 26XX Velour Alkyd Semi-Gloss Enamel.
 - 2) Gidden: 4200 Spred Ultra Semi-Gloss Enamel.
 - 3) Moore: Moore's Sating Impervo Enamel #235.
 - c. Cotton or Canvas Covering Over Insulation Interior Flat Latex Emulsion Size:
 - 1) Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - 2) Gidden: 3400 Spred Satin Latex Wall Paint.
 - 3) Moore: Regal Wall Sating #215.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Thoroughly clean all surfaces to be painted as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application. The painting of piping associated with an operating system is strictly prohibited. Site touch-up of the factory applied coating or paint, to include preparation and painting of field welds, must be completed and approved by the Engineer prior to installation of insulation (No Exceptions).

3.2 INSTALLATION

- A. General: The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings. For example, pumps will be identified as 3A, 3B, 3C, etc.; exhaust fans will be E-1, E-2, etc.; supply fans will be S-1, S-2, etc.
- B. Mechanical: All items of mechanical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed Gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:
 - C. Electrical: Nameplates shall be 2 or 3 ply laminated plastic, a minimum of 3/32" thick, such that letters will be white on black background. Letters shall be similar to Roman Gothic of a size that is legible and appropriate to the application. Attachment of nameplates shall be by screws. Rivets or adhesives are not acceptable.
 - D. Electrical equipment to be identified includes: All switchgear, distribution panels, transformers, motor control centers, panel boards, disconnect switches, starters, contactors and time switches.
 - E. Nameplates on distribution panels, motor control centers and panel boards shall give voltage characteristics.
 - Example:
PANEL LA
120/208V, 3 PH, 4 W
served from.
 - F. Individual circuit breakers in distribution panels, individual units in motor control centers, disconnecting means, and motor starters, shall have nameplates showing the load served.
 - G. Branch circuit panel boards shall have neatly typed circuit directories behind clean plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner, not necessarily those given on contract Drawings. If a circuit serves more than one room, list each room. Spares and spaces shall be indicated with erasable pencil, not typed.
 - H. The Contractor shall prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each

valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:

HWS-1-3 Hot water Supply	1st Level - Valve No. 3
CHS-2-4 Chilled Water Supply	2nd Level - Valve No. 4

3. 3 VALVE TAGS

- A. The Contractor shall provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves except simple service and drain valves located within 10' and within sight of the device or equipment served. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. These tags shall be 1/8" thick brass discs, 1 1/2" in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.
- B. Valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2 1/2" wide by 1 1/2" high with these color codings: Red = normally closed; Green = normally open; Blue = open in winter, closed in summer; and Yellow = closed in winter, open in summer. Tags should be engraved on both sides.
- C. In addition, pipe runs throughout the building including those above lift out ceilings, under floor, and those exposed to view when access doors or access panels are opened shall be identified by means of Seton Setmark or Brady Mechanical Pipe Markers. Concealed areas, for purposes of this identification section, are those areas which cannot be seen except by demolition of the building elements. In addition to the pipe markers, arrow markers shall be used to indicate direction of flow. The following specific instructions shall apply to the application of these markers:
 - D. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one header, it is necessary to mark only the header.
 - E. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.
 - F. Provide a double ended arrow marker when flow can be in either or both directions.
 - G. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line goes through a wall or service column.
 - H. Provide pipe markers and arrow markers at intervals not exceeding 50 feet.
 - I. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.
 - J. Use Seton Setmark Type SNA or Brady Snap-on type identification for all piping systems, 3/4" thru 6". For piping systems larger than 6", use Seton or Brady strap on markers.
 - K. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems." Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
 - L. Locate markers to be visible from floor.

- M. Plastic Nameplates: Secure nameplates to equipment fronts using corrosive resistant screws and rivets. Install nameplates parallel to equipment lines.
- N. Metal Tags: Install with corrosive-resistant chain and “j-hook.”
- O. Stencil Painting: Apply single coat sufficient to cover background completely with minimum 4 mils dry film thickness.
- P. Plastic Pipe Markers: Install in accordance with manufacturer’s instructions.
- Q. Plastic Tape Pipe Markers: Install completely around pipe in accordance with manufacturer’s instructions.
- R. Underground Plastic Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.
- S. Equipment
 - 1. Identify mechanical equipment scheduled on Drawings with nameplates, except of air devices, sprinkler heads, plumbing fixtures, and plumbing shock absorbers.
 - 2. Identify name, number, function, capacity, and other pertinent information of air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates.
- T. Controls: Identify control panels and major control components outside panels with plastic nameplates.
- U. Valves: Identify with metal tags, ALL valves in main and branch piping connections to equipment, and all run out piping to coils with metal tags.
- V. Fire Dampers: Label with plastic nameplates in accordance with NFPA 90A.
- W. Piping
 - 1. Paint all exposed piping, including insulated piping, in mechanical and equipment rooms with colors to meet ANSI standards. In addition, identify all piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 10 feet on straight runs, including risers and drops, adjacent to each valve and tee at each obstruction. Provide a flow arrow at each identification marker.
 - 2. Paint all exposed piping, including insulated piping, with primer and undercoat only. Provide color samples to the Architect for selection from the manufacturer’s full range of standard colors. Refer to Section 090190 for finish coat compatibility.
- X. Ductwork:
 - 1. Paint all exposed ductwork with primer and undercoat only. Provide color samples to the Architect for selection from the manufacturer’s full range of standard colors. Refer to Section 090190 for finish coat compatibility
 - 2. Paint all ductwork, except as indicated above, with stenciled painting. Identify as to air handling unit number, zone number, and area served. Locate identification at air handling unit, at each side of all wall and floor penetrations or enclosures and at each obstruction.
 - 3. Preparation:

- a. Examine substrates and conditions under which painting is to be performed for compliance with paint application requirements. Surfaces receiving paint must be thoroughly dry before paint is applied.
 - b. Before applying paint or other surface treatments, thoroughly clean substrates of substances that could impair the bond of the various coatings. Remove all oil and grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
 - c. Clean and prepare surface to be painted according to the manufacturer's instruction for each particular substrate condition and as specified.
 - d. Clean galvanized surfaces with nonpetroleum-based solvents so that the surface is completely free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal by mechanical methods.
 - e. Do not begin to apply paint until unsatisfactory conditions have been corrected.
 - f. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
4. Application
- a. Apply paint to all ductwork surfaces as previously indicated, according to manufacturer's directions. Use applicators and techniques best suited to the substrate and type of material being applied.
 - b. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 1) Paint colors, surface treatments, and finishes are indicated in the schedules.
 - 2) Provide primers and undercoats that are compatible with finish coats used (No Exceptions).
 - 3) The number of coats and film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.
 - c. Apply additional coats if undercoats, stains, or other conditions show through finish coat of paint until paint film is of uniform finish, color, and appearance. Provide special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
 - d. The term "exposed piping and ductwork surfaces" is defined to include all visible or open-to-view areas, related hangers, supports, diffusers, grilles, and other similar components. Extend coating in these areas, as required, to maintain the system integrity and provide the desired protection.
 - e. Paint interior surfaces of all ducts, where visible through grilles, registers, or diffusers, with flat, non-specular black paint.
 - f. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer or as herein specified, whichever is the greater.
 - 1) Primer: Apply a minimum of two coats with a total dry film thickness of not less than 2.5 mils.
 - 2) Undercoat: Apply a minimum of two coats over primer with a total dry film thickness of not less than 2.5 mils.
 - 3) Lusterless (Flat) Finish: Apply a minimum of two coats over primer and undercoat with a total dry film thickness not less than 2.5 mils.
 - 4) Semi-gloss Finish: Apply a minimum of two coats over primer and undercoat with a total dry film thickness not less than 3.0 mils.

Y. Use identification of equipment on the "Record Drawings" for nameplate designations.

- Z. Attach identification for items such as special switches, etc., located in finished areas, on or in the immediate vicinity of the item.

3. 4 VALVE CHART AND SCHEDULE

- A. Provide valve chard and schedule in aluminum frame with clear plastic shield. Install on in each individual equipment room at locations as directed engineer or Owner.

3. 5 COLOR CODE FOR MARKING PIPE

MATERIAL	BAND	LETTERS AND ARROWS	LEGEND
Cold water (portable) WATER	Green	White	PORTABLE
Fire protection water (WATER)	Red	White	FIRE PR.
Hot water (domestic)	Green	White	H.W.
Hot water re-circulating (domestic)	Green	White	H.W.R.
Heating water supply	Yellow	Black	L.TW.S.
Heating water return	Yellow	Black	L.T.W.R.
Chilled water supply	Green	White	C.H.W.S.
Chilled water return	Green	White	C.H.W.R.
Treated water	Yellow	Black	TR. WATER
Chemical feed	Yellow	Black	CH. FEED

3. 6 COLOR CODE FOR MARKING SIZES

OUTSIDE DIAMETER OF PIPE COVERING (INCHES)	LENGTH OF COLOR BAND (INCHES)	ARROW LENGTH BY WIDTH (INCHES)	SIZE OF LEGEND LETTERS AND NUMBERS (INCHES)
Less than 1-1/2	8	8 x 2-1/4	1/2
1-1/ to 1-3/8	8	8 x 2-1/4	3/4
2-1/2 to 1-7/8	12	8 x 2-1/4	1-1/4

8 to 10	24	12 x 4-1/2	2-1/2
Over 10	32	12 x 4-1/2	3-1/2

END OF SECTION 23 05 53

23 05 93

SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Sections:
 - 1. Section 013300 Submittals.
 - 2. Section 01524 Construction Waste Management
 - 3. Section 01352 LEED Requirements
 - 4. Section 01611 Environmental Management
 - 5. Section 01570 Pollution Prevention and Control

1.2 RELATED DOCUMENTS

- A. Contract Documents, General Requirements for Building Construction and Related Work, apply to work specified in this section.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.3 SCOPE

- A. An independent Testing, Adjusting and Balancing (TAB) Contractor for the HVAC systems shall be selected by Owner and paid by Contractor and conform as part of this contract. TAB contractor shall not be hired by general contractor or any sub-contractor. Mechanical Contractor shall provide all assistance and information requested by the TAB contractor.
- B. This section provides for the testing and balancing, of all systems and equipment. Refer to section 019113 for commissioning requirements.
- C. These tests are required to determine that all systems and equipment involved may be safely energized and equipment.
- D. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.
- E. Record all test data.
- F. Each section of Divisions 22 and 23 that has the products or systems listed herein, incorporate this section by reference and is incomplete without the required tests stated herein.
- G. This Section includes testing, adjusting, balancing HVAC systems and alarm point reporting verification to produce design objectives, including the following:
 - 1. Balancing airflow and water flow within distribution systems, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Testing, adjusting, and balancing of Hydraulic piping systems.
 - 5. Testing, adjusting, and balancing of refrigerating systems.
 - 6. Measurement of final operating condition of HVAC systems.

7. Sound measurement of equipment operating conditions.
8. Setting quantitative performance of HVAC equipment.
9. Verifying that automatic control devices are functioning properly and perform their intended functions.
10. Calibrating automatic temperature control sensors.
11. Verification of building alarm and alarm remote monitoring.

1.4 QUALIFICATIONS

- A. The independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or by the Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by NEBB or AABC as a Test and Balance Engineer.
- B. The Firm shall have operated a minimum of five (5) years under its current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status.
- C. The Firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted, or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.
- D. All personnel used on the job site shall be either professional engineers or engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.
- E. The TAB firm shall submit biographical data on the individual proposed who will directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.
- F. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of the system operation and readiness for testing, adjusting, and balancing.
- G. Test, adjust, and balance the air systems before hydraulic, steam, and refrigerant systems.
- H. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within five degrees Fahrenheit wet bulb temperature of maximum summer design condition, and within ten degrees Fahrenheit dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.
- I. Approved TAB Contractors:
 1. Engineered Air Balance
 2. Precision Air

1.5 SERVICES OF THE MECHANICAL CONTRACTOR

- A. Contractor shall provide all volume dampers, balancing dampers, balancing valves, test ports and Pete's plugs as required by the Testing and Balancing Firm.
- B. Contractor shall furnish a set of sheet metal shop drawings and HVAC piping drawings to the Testing and Balancing Firm during the submittal phase and incorporate the Testing and Balancing Firm's mark-ups and requests into the project.
- C. Contractor shall provide all required equipment to facilitate Testing and Balancing Firm's work. This coordination shall be included in the Contractor's base bid price.
- D. Provide, correct, repair or replace deficient items or conditions found during the testing and balancing.
- E. Provide replacement sheaves as directed by TAB Contractor to achieve scheduled air volumes.
- F. For motors with a variable frequency drive, contractor shall provide belt and sheave adjustment such that units deliver their design CFM when speed drive is at 60 hertz.
- G. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place or in normal position.
 - 15. Service and balancing valves are open.
 - 16. 1Re-sheave

1.6 REPORTS

- A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one set of mechanical specifications, all pertinent change orders, and the following:
 - 1. One complete set of Drawings less the structural sheets.
 - 2. One set of mechanical floor plans of the conditioned spaces. These Drawings shall be hard copy and PDF type to facilitate marking.
- B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.06 through 1.10 of this Specification will be available through the Construction Inspector.
- C. Submit test report forms for review a minimum of 30 days prior to requesting a final review by the Architect/ Engineer.

- D. Furnish six (6) individually bound copies of test data. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements take, both prior to and after any corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation.
- E. The Architect will retain on (1) copy and the Engineer will retain one (1) copy. The remaining four (4) copies will be returned to the Contractor for inclusion in the operation and maintenance manuals. Refer to Division 01 – Closeout Submittals.

1.7 REFERENCES

- A. AABC. 1989. National Standards for Total System Balance, 5th edition.
- B. AABC. 1997. Testing and Balancing Procedures.
- C. ASHRAE – 1999 Applications Handbook: Chapter 36 – Testing, Adjusting and Balancing.
- D. ASHRAE – 1999 Applications Handbook: Chapter 41 – Building Commissioning.
- E. ASHRAE – 1999 HVAC Application Handbook: Chapter 46, Sound and Vibration Control.

1.8 RESPONSIBILITIES OF THE TAB FIRM

- A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC 1989 Standard, Fifth Edition.
- B. Liaison and Early Inspection:
 - 1. The TAB firm personnel shall support on the job the commissioning authority responsible to act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:
 - a. During the design stage, before the documents are finalized, review the mechanical drawings and specifications for balance ability and provide commentary.
 - b. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to commissioning work and balance ability.
 - c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Commentary will be provided to the RCM of each observation.
 - d. Test one (1) 8" single duct terminal box for performance capability and leakage as described in Section 23 36 00. The shipment of the box to the TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received at the TAB Agency.
 - e. Test one (1) 8" dual duct box for performance capability and leakage as described in Section 23 36 00. The shipment of the box to the TAB Agency's lab will be at

the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received by the TAB agency.

- f. Test 10% of the single and dual duct boxes for casing and damper leakage when the shipment arrives at the project site. All testing (except for the initial boxes) shall be performed on site. Boxes requiring re-testing will be charged to the Contractor at the unit price provided to the Owner.
- g. Test one (1) lab configuration including fume hood with air valve, general exhaust air with air valve and supply air with air valve for performance capability through a full range of inlet pressures. The tracking capability of the exhaust air versus the supply air will be with the submitted hood sash fully open and as the sash is closed in 2" increments until fully closed. Track the three (3) valves' response time in relation to sash movement and the lab differential.
 - 1) During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.9 VABRIATION TESTS

A. Location of Points for Air Handling Unit Fans and all other Fans:

- 1. Fan bearing, drive end.
- 2. Fan bearing, opposite end.
- 3. Motor bearing, center (if applicable)
- 4. Motor bearing, drive end.
- 5. Motor bearing, opposite end.

B. Test Readings.

- 1. Horizontal, velocity and displacement.
- 2. Vertical, velocity and displacement.
- 3. Azial, velocity and displacement.

C. Normally acceptable readings, velocity and acceleration.

D. Unusual conditions at time of test.

E. Vibration sources (if non-complying)

1.10 FINAL AIR BALANCE

- A. General: When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within $\pm 5\%$ of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch

ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:

1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.
2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Division 23 Contractor shall make any required changes.
3. Ampere Readings: Measure and record full load amperes for motors.
4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.
5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.
6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).
7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.
8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.
9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.
10. Maximum and minimum air flow on terminal boxes.

1.11 SOUND VIBRATION AND ALIGNMENT

- A. Sound: Read and record sound levels at up to 15 locations in the building designated by the Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet in the presence of the Engineer, if he so desires.
- B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 HP. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed 1 mil on fans and 1 mil on pumps unless otherwise specified. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.12 TESTING OF TEMPERATURE CONTROL SYSTEMS

- A. In the process of performing the TAB work, the TAB Agency shall:
 1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.
 2. Verify that all control devices are properly connected.

3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).
5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes and fire/smoke dampers.
6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
7. Observe the calibration of all controllers.
8. Verify the proper application of all normally opened and normally closed valves.
9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.
10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.
12. Verify that all controller setpoints meet the design intent.
13. Check all dampers for free travel.
14. Verify the operation of all interlock systems.
15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

B. A systematic listing of the above testing and verification shall be included in the final TAB report.

1.13 SUBMITTALS

A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.

6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Follow industry standard practices and procedures for testing, balancing, as listed in paragraph 1.3 above.
- B. The A/E must be notified a minimum of 72 hours prior to any tests being conducted.
- C. The TAB Contractor must be notified a minimum of five working days prior to conduction any duct leakage tests and same must be present to witness all duct leakage tests.

3.2 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for **50 percent** loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries in clean rooms.

3.3 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - b. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - c. Measure static pressure directly at the fan outlet or through the flexible connection.
 - d. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - e. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - b. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - c. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

- d. Obtain approval from construction manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - e. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.
- 1. Measure airflow of sub-main and branch ducts.
 - 2. Where sufficient space in sub-main and branch ducts is unavailable for Pitot tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 3. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 4. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.
 - 5. Measure air outlets and inlets without making adjustments.
- C. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
- 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- 3.4 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS
- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
- 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

6. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
7. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
8. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
9. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
10. Record final fan-performance data.

3.5 MECHANICAL EQUIPMENT

A. Verify the following:

1. Equipment is operable and in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Correct fan rotation.
7. Fire and volume dampers are in place and open.
8. Coil fins have been cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and operable.
11. Duct system leakage has been minimized.
12. Pretest components in the VFD. Provide factory certification of testing the entire VFD with varying induction motor loads for 24 hours prior to shipment.
13. Proper sequencing and operation of all DDC Control System components and equipment as required by ASHRAE Standard on Total Building Mechanical System operation.
14. Perform sound power level tests and provide required data on each occupied space adjacent to, above, or below mechanical/ air handling unit equipment rooms.
15. Perform vibration test and provide required data on each piece of air handling/ ventilation equipment or fan. Vibration testing must be complete in compliance with the requirements of ASHRAE – 1999 HVAC applications Handbook Chapter 46, Sound and Vibration Control and the maximum listed RMS values listed herein.

B. Duct Leakage

1. Test all supply air ductwork, to include, but not limited to, downstream of all single zone and multi-zone air handling units, downstream of all VAV air handling units and upstream of fan powered terminal units at 2-1/2 inches of static pressure (except where this requirement would exceed the ductwork design pressure classification) to have a total leakage value not to exceed 2% of the total system airflow.
2. Test all supply, return, and exhaust air ductwork, to include, but not limited to, downstream of fan coil units and fan powered terminal units, upstream of air handling units, and upstream and downstream (where applicable) of fans at 1-1/2 inches of static pressure to have a total leakage value not to exceed 2% of the total system design airflow.
3. Ductwork that initially fails these tests shall be replaced, modified, resealed, etc. as required to meet the leakage requirement and then re-tested to ensure compliances.

3.6 REPORTS

- #### A.
- The activities described in this section shall culminate in a report to be provided in quadruplicate (4) individually bound to the RCM. Neatly type and arrange data. Include with the data the date

tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.

- B. All measurements and recorded readings (of air, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or engineers of the firm.
- C. At the option of the Construction Inspector, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Construction Inspector. Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.
- D. Submit reports on forms approved by the Owner & Engineer which will include the following information as a minimum:
 - 1. Title Page
 - a. Company Name
 - a. Company Address
 - b. Company telephone number
 - c. Project name
 - d. Project location
 - e. Project Manager
 - f. Project Engineer
 - g. Project Contractor
 - h. Project Identification Number
 - 2. Instrument List
 - a. Instrument
 - a. Manufacturer
 - b. Model
 - c. Serial Number
 - d. Range
 - e. Calibration date
 - f. What test instrument was used for
 - 3. Fan Data (Supply and Exhaust)
 - a. Location
 - a. Manufacturer
 - b. Model
 - c. Air flow, specified and actual
 - d. Total static pressure (total external), specified and actual
 - e. Inlet pressure
 - f. Discharge pressure
 - g. Fan RPM
 - 4. Return Air/Outside Air Data (If fans are used, same data as for 3 above)
 - a. Identification/location
 - a. Design return air flow
 - b. Actual return air flow
 - c. Design outside air flow
 - d. Return air temperature
 - e. Outside air temperature
 - f. Required mixed air temperature
 - g. Actual mixed air temperature
 - 5. Electric Motors
 - a. Manufacturer
 - a. HP/BHP
 - b. Phase, voltage, amperage, nameplate, actual
 - c. RPM

- d. Service factor
- e. Starter size, heater elements, rating
- 6. V-Belt Drive
 - a. Identification/location
 - a. Required driven RPM
 - b. Driven sheave, diameter and RPM
 - c. Belt, size and quantity
 - d. Motor sheave, diameter and RPM
 - e. Center-to-center distance, maximum, minimum and actual
- 7. Duct Traverse
 - a. System zone/branch
 - a. Duct size
 - b. Area
 - c. Design velocity
 - d. Design air flow
 - e. Test velocity
 - f. Test air flow
 - g. Duct static pressure
 - h. Air temperature
 - i. Air correction factor
- 8. Air Monitoring Station Data
 - a. Identification/location
 - a. System
 - b. Size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
- 9. Air Distribution Test Sheet
 - a. Air terminal number
 - a. Room number/location
 - b. Terminal type
 - c. Terminal size
 - d. Area factor
 - e. Design velocity
 - f. Design air flow
 - g. Test (final) velocity
 - h. Test (final) air flow
- 10. Cooling Coil Data
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Entering air DB temperature, design and actual
 - f. Entering air WB temperature, design and actual
 - g. Leaving air DB temperature, design and actual
 - h. Leaving air WB temperature, design and actual
 - i. Air pressure drop, design and actual
- 11. Heating Coil Data
 - a. Identification/number
 - a. Location
 - b. Service
 - c. Manufacturer
 - d. Air flow, design and actual

- e. Entering air temperature, design and actual
- f. Leaving air temperature, design and actual
- g. Air pressure drop, design and actual
- 12. Sound Level Report
 - a. Location (Location established by the design engineer)
 - a. NC curve for eight (8) bands - equipment off
 - b. NC curve for eight (8) bands - equipment on
- 13. Vibration Test on equipment having 10 HP motors or above
 - a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end
 - 3) Motor bearing, center (if applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing (bottom or top)
 - 7) Casing (side)
 - 8) Duct after flexible connection (discharge)
 - 9) Duct after flexible connection (suction)
 - b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
 - c. Normally acceptable readings, velocity and acceleration
 - d. Unusual conditions at time of test
 - e. Vibration source (if non-complying)
- 14. Control verification indicating date performed and any abnormalities identified.
 - a. Point Location/Description
 - b. EMS Readout (Setpoint and Actual)
 - c. Actual Readout
 - d. Interlocks
 - e. Safeties
 - 1) VSD Normal Operation
 - 2) VSD Bypass Operation
 - f. Alarms
 - g. Sequences of Operation

END OF SECTION

PART 4 -

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HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Retain or delete this article in all Sections of Project Manual.
- B. Furnish and install thermal insulation for mechanical and plumbing piping systems including jackets and accessories.
- C. Insulation systems for sheet metal duct conveying cold, hot and grease laden air. Provide duct insulation systems which have been manufactured, fabricated and installed to meet all thermal requirements of mechanical systems. Insulating systems shall be installed in strict accordance with manufacturer's field requirements and the current International Energy Conservation Code.
- D. HVAC system includes horizontal roof drain, lines, and waste lines which receive condensate from air handling units or evaporators.

1.2 RELATED SECTIONS

- A. Section 090190 – Maintenance of Painting and Coatings.
- B. Section 230529 – Hangers and Supports for HVAC Piping and Equipment.
- C. Section 230553 – Mechanical Identification
- D. Section 013300 Submittals.
- E. Section 01524 Construction Waste Management
- F. Section 01352 LEED Requirements
- G. Section 01611 Environmental Management
- H. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- A. ASTM C 178 – Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-HOT-Plate Apparatus.
- B. ASTM C 195 – Mineral Fiber Thermal Insulation Cement.
- C. ASTM C 533 – Calcium Silicate Block and Pipe Thermal Insulation.
- D. ASTM C 534 - Preformed Flexible Elastomeric Cellular Thermal Insulation.
- E. ASTM C 547 – Mineral Fiber Preformed Pipe Insulation.
- F. ASTM C 591 – Preformed Cellular Polyurethane Thermal Insulation.

- G. ASTM C 1126 – Rigid Cellular Phenolic Thermal Insulation.
- H. ASTM B 209 – Aluminum and Aluminum-alloy Sheet and Plate.
- I. ASTM E 84 – Surface Burning Characteristics of Building Materials.
- J. ASTM E 96 –Water Vapor Transmission of Materials.

1.4 SUBMITTALS

- A. Include product description, list of materials, and thickness for each service and locations.
- B. Include detail drawings of insulation dams.
- C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- A. Application Company Qualifications: The installing company must be solely and exclusively in the business of insulation installation for the previous consecutive five year period. The installing company must also be regularly engaged in installing the specific specified insulation material types on projects of equal or greater magnitude and scope as this project for the previous consecutive five year period. Documentation of the above listed requirements must be submitted prior to insulation material submitted.
- B. Application Personnel Qualifications: The installing company must provide qualified installation personnel on this project jobsite directly employed by them who are skilled and proficient at installing the specific specified insulation Material types.

- C. Any material found, by the A/E, to be improperly installed or not installed in total compliance with the specific installation instructions and methods (written or implied) of the material manufacturer must be removed by the installing company. The preparation instructions must be followed prior to the re-installation of the insulation material using the correct installation instructions and methods of the material manufacturer.
- D. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.
- B. All insulation shall comply with IECC 2012.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. Insulation

1. Owens-Corning Fiberglass Corporation.
2. UpJohn CRP/DOW Chemical Company.
3. Knuff Corporation.
4. FGH Fabricators, Inc.
5. Armstrong.
6. Quiet Liner by Acoustical Surfaces Inc.

B. Jackets

1. Childers Products Company.
2. PABCO.
3. RFR Products, Inc.
4. Kinetics Duct Wrap

2.5 PIPE INSULATION

- A. Type B-1: Elastomer, closed cell, flexible, insulation; ASTM E 96, maximum vapor transmission rating of 0.20 pers; ASTM C 177; 'k' value of 0.27 at 75 degrees F.
- B. Type B-2: Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated. (Indoor locations only).

2.6 DUCT INSULATION MATERIALS

- A. Type C: Flexible Fiberglass Duct Insulation (Indoor application): ASTM C 553, Type I, Class B-4, 2 " thick, 1.0 PCF density, minimum R-6 (installed) with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
- B. Type D: Rigid Fiberglass Duct Insulation (Indoor application): ASTM C 612, Class 1, 2" thick, 3.0 PCF densities, for both supply and exhaust round ducts exposed to view locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid wrap® for all round ducts in areas without ceiling.
- C. Type E: Rigid Foam Glass Duct Insulation (Outdoor application): Foamglas ONE™ block with 7.3 lbs/ft³ and 0.29 BTU-inch /hr F thermal conductivity per ASTM C 240, Type I.
- D. Type F: Quiet Liner by Acoustical Surfaces Inc. or approved equal. Quiet Natural Fiber Liner shall be thermally bonded HVAC insulation with superior acoustic and thermal performance. Liner shall be made from natural fibers; Quiet Liner™ shall not contain fiberglass. The fibers used to manufacture Quiet Liner shall offer sound absorption properties. The air stream surface shall be overlaid with a durable, fire-resistant black facing, to provide additional strength to the product. Both the insulation and the facing shall be treated with an EPA registered anti-microbial agent. Surface Burning Characteristics shall be less than 25/50 shall be Class A / Class 1 per ASTM E84, UL 723, and NFPA 255. Fungi Resistance shall indicate no growth per ASTM C1338 and ASTM C739. Water Vapor Absorption shall be less than 1% by weight per ASTM C1104.
- E. Jackets for Duct Insulation: ASTM C 921, Type I for duct with temperatures below ambient; Type II for duct with temperatures above ambient.
- F. Jackets for outdoor Duct Insulation: Encase exterior duct insulation with 16 MIL Stainless steel jacket with "Z" closures for weather-proof construction.
- G. Duct Insulation Accessories: Provide bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

- H. Mechanical Fasteners:
 - 1. Gemco Type IH-A from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
 - 2. Eckoustic-Klip from Eckel Industries Inc., Cambridge, MA 617-491-3221.
 - 3. INC Stick-Pin from Industrial Noise Control Inc. Addison, IL 312-620-1998.

- I. Duct Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.
 - 1. 15-141 from King Co., St. Louis, MO 314-772-9953.
 - 2. Tuffbond from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
 - 3. INC C-700 from Industrial Noise Control Inc., Addison, IL 312-620-1998.

- J. All external duct wrap shall be 2 " thick, 1.0 P.C.F. density minimum, and is required on all and supply air duct that also meets with the minimum R-value per International Energy Code 2013. External duct wrap shall be with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.

2.7 DUCTWORK JACKETS

- A. Interior, Concealed Applications
 - 1. Type D Insulation: one and a half (1½") pounds per cubic feet minimum density semi-rigid glass fiber. Provide factory applied ASJ white kraft foil vapor barrier. Type B Insulation: Finish coat is not required.
 - 2. Insulate fittings, joints and valves with molded insulation of like material and thickness as adjoining pipe. Use insulating cement to fill voids and cracks. Finish with #10 glass membrane and Childers #CP-30 L.O. vapor barrier mastic.

- B. Interior, Exposed Applications
 - 1. Double wall duct and fittings will consist of a solid inner liner, 1" thick x 1.0 lb/ft³ layer of glass fiber insulation, and a solid outer pressure shell.
 - 2. Double wall jacket with spiral lockseam with standing rib.
 - 3. Fitting ends shall be sized to slip-fit into spiral duct of the same nominal size.

- C. Exterior Applications
 - 1. Prime sheet metal with Pittcote 300 before the installation of insulation.
 - 2. Insulate exterior ductwork with 2 layers of 1½" thick FOAMGLAS sheet.
 - 3. Wrap insulation with 8 oz canvas. Finish with 2 coats on 8 oz canvas shall be Childers CP-50 prior to final jacket installation.
 - 4. Cover with 0.02 inch thick stainless steel jacket having integral moisture barrier with seams located at 2 or 10 o'clock position of horizontal piping. All laps must be minimum 2".

- D. Jacket Materials
 - 1. Factory Applied Jackets: White kraft bonded to reinforced foil vapor barrier with self-sealing adhesive joints.
 - 2. PVC Jackets: One piece, pre-molded type, to meet flame spread and smoke developed rating of 25/50 in accordance with ASTM E 84.
 - 3. Canvas Jackets: UL listed treated cotton fabric, 8 ounces per square
 - 4. Fiberglass Cloth Reinforcing Mesh: #10 glass cloth with minimum weight of 3.9 ounces per square yard.
 - 5. Aluminum Jackets: (Indoor applications exposed to view) ASTM B 209, 0.020 inch thick; smooth finish with factory applied moisture barrier.
 - 6. Stainless Steel Jackets: (Outdoor applications) Type 304 stainless steel; 0.010 inch thick; smooth finish.

2.8 ACCOUSTICAL DUCT WRAP (TYPE L)

- A. The sound control lagging material is applied continuously as part of the duct system to reduce sound transmission from the duct i.e., control breakout noise.
- B. Material shall consist of a rugged, reinforced aluminized-faced, mass loaded limp vinyl barrier, 9.8-kg/m² (2-psf). Material shall be non-lead composition for safe handling and easy installation.
- C. Pipe and duct shall be wrapped with fiber glass batt or other appropriate resilient material in order to decouple sound control lagging from surface of pipe and duct. For the required optimal performance, sound control lagging shall be installed / wrapped over the duct thermal insulation and shall not be applied directly to surface of duct.
- D. The sound control lagging material shall be provided by a manufacturer having a minimum of five years' experience in furnishing similar noise control lagging material for pipe and duct.
- E. The barrier shall be constructed of a 6-mm (0.24") thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 9.8-kg/m² (2.0-psf).
- F. Sound control lagging material shall be Kinetics Noise Control, Inc. Model KNM-200AL or equal.
- G. Products not meeting minimum test standards will not be accepted. Submittals shall include test reports from independent laboratories meeting the following minimum criteria:
- H. Insertion Loss when tested as a duct wrap over 51-mm (2") thick, 80.1 kg/m (5-pcf) fiber glass over a 20-gauge duct system (per ASTM E1222-90)

1.

Frequency, Hz	63	125	250	500	1000	2000	4000
	5	9	18	28	34	37	37

2.9 ACCESORIES

- A. A. Insulation Bands: 3/4 inch wide; 0.015 inch thick galvanized steel, stainless steel or 0.007 inch thick aluminum.
- B. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.
- C. Insulating Cement: ASTM C 195; hydraulic setting mineral wool; Ryder One-Coat.
- D. Sealants: Used at valve, fittings and where insulation is terminated. Brushes apply sealant to end of insulation and continued along pipe surface. Provide Childers CP-30 L.O. sealant.
- E. Adhesives: Used to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP-82 or approved equal as general purpose adhesive. Use Childers CP-97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the insulation.
- F. Primers: Provide Childers CP-50 diluted 50% with water primer to cover insulating cements prior to finish coating.

PART 3 - EXECUTION

3.1 PIPE PREPARATION

- A. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application.
- B. The installation of piping insulation associated with an operating chilled water system is strictly prohibited.
- C. Provide primer coat on all piping, to include field welds and over factory applied paint/ coating, in total compliance and compatible with and approved by the Engineer prior to installation of insulation (No Exceptions).
- D. Install insulation material only after all performance tests on piping have been completed and approved by the Engineer (No Exceptions).

3.2 PIPE INSULATION INSTALLATION

- A. Install materials in complete and total compliance with the specific manufacturer's installation instructions.
- B. Continue vapor barrier through wall and floor penetrations.
- C. In exposed piping, locate insulation and cover seams in least visible locations.
- D. Insulate fittings, valves, flanges and strainers. On flexible connections, expansion joints and unions, bevel and seal ends of insulation and continue sealant a minimum of 4 inches along the piping.
- E. Provide dams in insulation at intervals not to exceed 20 feet to prevent migration of condensation or leakage.
- F. Provide an insert of same thickness and contour as adjoining insulation, between support shield and piping, and under the finish jacket, on piping 2 1/2 inch diameter or larger, to prevent insulation from sagging at support points. Provide inserts for 180-degree arc and not less than the length of the pipe support shield or minimum 12 inches long (whichever is greater) manufactured of 5.0# density cellular phenolic insulation material suitable for the planned temperature range. Factory fabricated inserts with integral galvanized pipe saddles are recommended. Adhere pipe support shield to insulation with adhesive.
- G. Neatly finish and seal insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.
- H. Paint exposed pipe insulation in total compliance with Section 210553 and Section 090190.

3.3 DUCT SYSTEM INSULATION

- A. Insulate all supply, return fresh-air, outside-air, make-up air and exhaust ducts.
- B. Cold Ducts: Temperatures below the space dew point shall have the insulation vapor barrier be continuous and unbroken through inside walls, sleeves and floor openings. Where connection is made to fire or fire/smoke damper in wall or floor the vapor barrier must extend to the wall or

floor to prevent ambient air water vapor from condensing on the cold surfaces of the fire damper.

- C. Duct Wrap: Fasten all longitudinal and circumferential laps with outward clinching staples 3" on center. On rectangular ducts over 24" wide, apply as above and hold insulation in place on bottom side with mechanical pins and clips on 12" centers.
- D. Duct Wrap: Seal all joints, fastener penetrations and other breaks in vapor barrier with 3-inch-wide strips of white glass fabric embedded between two coats of vapor barrier mastic, Childers CP-30 or approved equal.
- E. Cold Duct (Below Ambient Temperature):
 - 1. Application Requirements: Insulate the following cold duct:
 - a. Outdoor air intake duct between air entrance and fan inlet or HVAC unit inlet.
 - b. HVAC supply duct between fan discharge, or HVAC unit discharge, and room terminal outlet.
 - 1) Insulate neck, backside, and bells of supply diffusers.
 - c. HVAC return duct between room terminal inlet and return fan inlet, or HVAC unit inlet.
 - d. HVAC plenums and unit housings not pre-insulated at factory or lined.
 - e. Exhaust duct work within the building non air-conditioned spaces.
 - 2. Insulate each duct system specified above with one of the following types and thicknesses of insulation:
 - a. Rigid Fiberglass: 2" thick, 3.0 PCF density, for both supply and exhaust round ducts exposed outdoor locations, or spaces without ceilings. Round duct insulation shall be E. O. Wood Rigid wrap® for all round ducts in areas without ceiling.
 - b. Flexible Fiberglass: 2" thick, 1.0 PCF density, minimum R-6 with foil faced continuous vapor barrier. This application is limited to concealed indoor locations only.
 - c. Foamglass: two (2) layers of 1" thick insulation blocks or 2" thick Armstrong Type II Armaflex flexible elastomeric closed cell sheet insulation or approved equal. (For outdoors locations).
 - d. Exhaust ductwork within the air-conditioned spaces do not require to be insulated. Exhaust duct on roof exposed to the outside weather do not require to be insulated.

3.4 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. For ductwork exposed in finished spaces.
 - 1. Double wall duct and fittings will consist of a solid inner liner, 1" thick x 1.0 lb/ft³ layer of glass fiber insulation, and a solid outer pressure shell.

2. Double wall jacket with spiral lockseam with standing rib.
 3. Fitting ends shall be sized to slip-fit into spiral duct of the same nominal size.
- E. External / Outdoor Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive to match jacket.
 2. Secure insulation without vapor barrier with staples, tape, or wires.
 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 6. Install 0.02" thick smooth Stainless steel jacket on ductwork installed outdoors / on roof.
- F. The sound control lagging material is critical in order to achieve the desired noise reduction. Sound control lagging material shall be cut to length, wrapped around the outside of the duct, and fastened with mechanical fasteners or bands. Tape and adhesive can be used in conjunction with mechanical fasteners or bands. All sound control lagging materials must be installed per the manufacturer's installation guidelines.
- G. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 100 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
 3. Seal and smooth joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
- H. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
- I. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unskillfully, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.
- J. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.
- K. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe,

duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.

- L. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
- M. Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.
- N. Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied three (3) to a section of pipe. Fittings, valves, etc., shall have bands on each side.
- O. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.
- P. Provide 2 hour enclosure on grease exhaust duct. Enclosure shall extend from kitchen hood to underside of roof deck.
- Q. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

3.5 SCHEDULE

A.

Duct or Piping	Type	Duct / Pipe Size	Insulation Thickness
Condensate Drain Lines (Interior Exposed)	B-1	All Sizes	1"
Refrigerant Suction Piping	B-1	2" & Smaller	1 ½"
Indoor ductwork Insulation Concealed Spaces	C	All sizes	2" & 1.0 lbs. density
All ductwork downstream from the VAV terminal units	L	All ducts All sizes	1" thick & 2 lbs. density.
Acoustical ductwork Liner In Transfer Ducts and Return Boots	F	All sizes	2" & 1.5 lbs density
Indoor ductwork Insulation Non-concealed Spaces Provide Aluminum Jacket	D	All sizes	2" & 3.0 lbs density
Outdoor Ductwork Insulation Provide 0.020"x 36" smooth Stainless steel Jacket	E	All sizes	two (2) layers of rigid 1 " thick, and 7.3 lbs/ft3 density

END OF SECTION

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EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Retain or delete this article in all Sections of Project Manual.
- B. Equipment insulation.
- C. Covering.

1.2 RELATED SECTIONS

- A. Section 090190 – Maintenance of Painting and Coatings.
- A. Section 232123 – Centrifugal Hydronic Pumps.
- B. Section 230553 – Identification for HVAC Piping and Equipment.
- C. Section 013300 Submittals.
- D. Section 01524 Construction Waste Management
- E. Section 01352 LEED Requirements
- F. Section 01611 Environmental Management
- G. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- A. First four paragraphs below are defined in Division 01 Section "Submittal Procedures" as "Action Submittals."
- A. ASTM C 195 – Mineral Fiber Thermal Insulation Cement.
- B. ASTM C 533 – Calcium Silicate Block and Pipe Thermal Insulation.
- C. ASTM C 534 - Preformed Flexible Elastomeric Cellular Thermal Insulation.
- D. ASTM C 553 – Mineral Fiber Blanket and Felt Insulation.
- E. ASTM C 591 – Preformed Cellular Polyurethane Thermal Insulation.
- F. ASTM C 612 – Mineral Fiber Block and Thermal Insulation.
- G. ASTM C 1126 – Rigid Cellular Phenolic Thermal Insulation.
- H. ASTM E 84 – Surface Burning Characteristics of Building Materials.

- I. ASTM 255 – Surface Burning Characteristics of Building Materials.
- J. UL 723 – Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Include product description, list of materials, and thickness for equipment scheduled.
- B. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- A. Application Company Qualifications: The installing company must be solely and exclusively in the business of insulation installation for the previous consecutive five year period. The installing company must also be regularly engaged in installing the specific specified insulation material types on projects of equal or greater magnitude and scope as this project for the previous consecutive five year period. Documentation of the above listed requirements must be submitted prior to insulation material submitted.
- A. Application Personnel Qualifications: The installing company must provide qualified installation personnel on this project jobsite directly employed by them who are skilled and proficient at installing the specific specified insulation Material types.
- B. Any material found, by the A/E, to be improperly installed or not installed in total compliance with the specific installation instructions and methods (written or implied) of the material manufacturer must be removed by the installing company. The preparation instructions must be followed prior to the re-installation of the insulation material using the correct installation instructions and methods of the material manufacturer.

- C. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.
- A. Insulation to provide minimum R-Value in accordance with International Energy Conservation Code with Houston Amendment.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. Owens-Corning Fiberglass Corporation.
- B. UpJohn CPR/ Dow Chemical Company.
- C. Manville Corporation.

- D. Armstrong.

2.5 INSULATION

- A. Type A: Mineral fiber or fiberglass preformed insulation: ASTM C 553; 'k' value of 0.24 at 75 degrees F; 2.0 lb/ cu ft. density.
- B. Type B: Rigid fiberglass or mineral fiber board; ASTM C 612; 'k' value of 0.24 at 75 degrees F; 6.0 lb/ cu ft. density.
- C. Type C: Molded closed cell polyisocyanurate insulation; ASTM E96, maximum water vapor transmission rating of 0.005 perm-in; ASTM C177, 'k' value of 0.18 at 75°F; ASTM D2842m water absorption value of 0.05 lb/ft².
- D. Type D: Calcium silicate; ASTM C 533; asbestos free; 'k' value of 0.40 at 250 degrees F.
- E. Type E: Closed cell, chemically neutral, neoprene insulation, 'k' value of 0.27 at 75 degrees F; sheet form; Armstrong Armaflex.
- F. Type F: Phenolic closed cell, ASTM C1126 rigid foam, 3.5 lbs. Nominal density, CFC free; ASTM C177, 'k' value of 0.18 at 75°F.

2.1 INSULATION METAL JACKET

- G. Provide Metal Jacket outdoors.
- H. Jacket - .016"x 36" aluminum smooth with moisture barrier jacket.
- I. Jacket - .020" x 36" aluminum smooth with moisture barrier jacket (High traffic areas).
- J. Aluminum fasteners – 3/4" bands, 3/4" wing seals .024 elbow covers.
- K. T-304 stainless steel fasteners – 1/2" x .020 bands, 1/2" wing seals.
- L. Screws are not to be used to secure jacketing.

2.6 ACCESSORIES

- A. Adhesives: Non-shrinking, permanently flexible, compatible with insulation. For general purpose use Childers CP-82 adhesive. For calcium silicate, use Childers CP-97 fibrous adhesive.
- B. Sealants: For general purpose to seal the end of the insulation, use Childers CP-30 L.O. sealant.
- C. Insulating Cement: ASTM C 195; hydraulic setting mineral wool; Ryder One-Coat.
- D. Wire Mesh: Corrosive-resistant metal; 1 inch hexagonal pattern.
- E. Primers: Use Childers CP-50 diluted 50% with water primer to seal over insulating cements and fibrous adhesives prior to finish coating.
- F. Finish Coats: For general purpose, use Childers CP-30 L.O. reinforce with glass cloth. For calcium silicate, use Childers CP-50 finish coat reinforced with canvas jacket. For finish coat over closed cell electrometric, use Childers CP-17 or Armstrong "Finish" acrylic finish.

G.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's installation instructions.
- B. Do not insulate factory insulated equipment.
- C. Do not insulate boiler or expansion or volume tank manholes, hand holes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- D. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Cover insulation with metal mesh and finish with heavy coat of insulating cement.
- G. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
- H. When equipment with insulation requires periodical opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Do not insulate factory insulated equipment.
- C. On exposed equipment, locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory applied or field applied.
 - 2. Finish with glass cloth and vapor barrier adhesive.
 - 3. Insulate entire system.
- G. For insulated equipment containing fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory applied or field ap-

- plied.
 2. Finish with glass cloth and adhesive.
 3. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
 4. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.
- H. Inserts and Shields:
1. Application: Equipment 2 inches diameter or larger.
 2. Shields: Galvanized steel between hangers and inserts.
 3. Insert location: Between support shield and equipment and under the finish jacket.
 4. Insert configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert material: Heavy density insulating material suitable for the planned temperature range.
- I. Finish insulation at supports, protrusions, and interruptions.
- J. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.
- K. For exterior applications, provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.
- L. Cover cellular glass and cellular foam insulation with aluminum jacket.
- M. Do not insulate over any nameplate or ASME stamps. Bevel and seal insulation around such.
- N. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.
- O. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
- P. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.
- Q. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

- R. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 15A.
- S. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
- T. Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.
- U. Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied three (3) to a section of pipe. Fittings, valves, etc., shall have bands on each side.
- V. Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.
- W. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.
- X. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

Y.

3.3 SCHEDULE

EQUIPMENT	TYPE	INSULATION THICKNESS
HOT EXPANSION TANKS PROVIDE ALUMINUM JACKET	E	2"
CHILLED WATER EXPANSION TANKS PROVIDE ALUMINUM JACKET	E	2"
AIR SEPARATORS	E	1"
HEAT EXCHANGER PROVIDE ALUMINUM JACKET	D	2 1/2"
COLD SURFACES (NOT FACTORY INSULATED)	E	1 1/2 "
CHILLED AND HOT WATER PUMP BODIES PROVIDE ALUMINUM JACKET	E	2"
CHEMICAL FEED (CHILLED/HOT WATER)	E	3/4"

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ENERGY MANAGEMENT AND CONTROL SYSTEM (EMCS)

PART 1 - GENERAL

1.1 GENERAL

- A. The Energy Management and Control System (EMCS) shall be comprised of a Local Area Network (LAN) infrastructure, Operator Workstations (OWS), Engineering Workstations (EWS), a Primary Network Server (PNS), Network Area Controllers (NAC), Application Specific Controllers (ASC), Unitary System Controllers (USC), and Field Devices installed within the facility.
- B. The Workstations, Primary Network Server, and Network Area Controllers shall be connected by an EMCS Contractor supplied and installed Local Area Network. The LAN shall comply with all IEEE Standards as outlined in: IEEE STD 802-2014: IEEE Standard for Local and Metropolitan Networks, Overview and Architecture.
- C. If the EMCS Contractor wishes connect to the Owner's Wide Area/Local Area Network as part of the control system network, the EMCS Contractor shall acquire permission in writing and include the letter in the submittal. Any system that requires connection to the Owner's network for communication between NAC, ASC, USC and/or field devices that is submitted without the written permission from the Owner shall be rejected. The EMCS Contractor shall coordinate with the Owner and supply all required information.
- D. Access to the system, either locally in the building, or remotely from a central site or sites, shall be accomplished through standard web browsers, via the Internet and/or a local area network. System shall be compatible across various devices including iPhone, Android and Windows phones and various tablets running these operating systems. Provide upgrades to the existing campus server as required to accomplish this requirement.
- E. All EMCS controllers and workstations shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2016, latest revision. Management level TCP/IP Ethernet network speeds shall be 1 Gbps minimum and the Automation Level MS/TP network speeds shall be 76.8 Kbps minimum.
- F. The Server shall gather data from the system and generate HTML5 pages accessible through a conventional web browser from all personal computers (PCs), tablets and mobile phones connected to the network. System shall include any and all software and hardware to support unlimited users. The EMCS shall be compatible with all common web browsers.
- G. Facility Operators shall be able to view and configure systems through the standard web browser and all graphical/data representations shall appear identical, whether the user is on site or viewing via the Internet at a remote location. Standard operator functions such as control point manipulation, configuration and viewing of trends, schedules and alarms shall be performed through the standard browser. Each mechanical system and building floor plan shall be depicted on the operator workstation by point-and-click graphics.
- H. The EMCS shall directly control HVAC equipment as specified in the Sequence of Operations. Furnish Energy Conservation features such as Optimal Start/Stop, Night Setback, Setpoint Reset logic, and Demand Control Ventilation.

- I. The EMCS vendor shall provide the following additional services as part of this Specification: warranty and service during the warranty period; submittals, samples and record documentation; comprehensive startup and testing of the EMCS with documentation; training services for the Owner and facility operators; coordination with other contractors and suppliers; operator and technician training program, and shall cooperate fully with the Project Commissioning Agent (CxA).
- J. Products furnished under this Specification but installed by others.
 - 1. Mechanical devices installed under Division 23 by the Mechanical Contractor or other suppliers: temperature sensing thermowells; automatic control dampers not installed in air handling unit mixing boxes or louver schedules; damper actuators for variable air volume (VAV) terminal units; mounting cost of controller and actuator for VAV terminal units.
 - 2. Electrical devices installed under Division 26 by the electrical Contractor:
 - a. 120 VAC power to controllers and control panels at locations indicated on the Drawings. Review and verify that these locations are adequate for the proposed EMCS.
 - b. Interlock wiring to duct mounted smoke detector or fire alarm shutdown relays to HVAC equipment motor starters, variable frequency drives (VFD) and etc.
- K. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.
- L. DDC system to be tied in to emergency button/switch to initiate shut down of all HVAC equipment when activated.
- M. System shall be fully compatible and interface with existing County system. Owner shall be able to use Maintenance Direct for Actions on individual Areas as needed and requested by Owner. Contractor responsible for all hardware, software and coordination involved.
- N. It is Contractor responsibility to discover and integrate all devices and points into system as necessary. This includes, but not limited to, HVAC, electrical, plumbing and lighting devices.
- O. It is the intent of this Specification to describe the basic architecture and performance requirements of the Energy Management and Control System (EMCS). The turn-key EMCS shall include all work station software including operator software, cables, programming tools, graphics editor, all other available software programs, modules, handhelds, or plug-ins offered by the DDC manufacturers, hardware, Control Units, Distributed Controllers, Unitary Controllers, Local Area Networks (LANs), sensors, modems, wiring, connectors, control devices, actuators, installation and calibration, supervision, adjustments and fine tuning necessary for a complete and fully operational system.
- P. Systems shall be furnished and installed complete in all respects, including any and all equipment, controls, wiring, instrumentation, enclosures, labor, engineering, training, commissioning, programming, supervision, calibration, coordination with other trades, etc. No information given in (or omitted from) these Specifications shall relieve the Contractor of this absolute requirement. Include all associated electrical work except as noted. Work includes furnishing of all labor, superintendence, materials, tools, equipment and sources necessary for the complete installation or modification of the following systems as herein specified. It is the intent of these Specifications that the Contractor shall furnish and install the systems complete in every respect and ready to operate. All equipment, miscellaneous items and accessories required for such installation and for the correct and convenient operation of the entire installation whether or not each such item or accessory is shown on the plans or mentioned in these Specifications shall be furnished and installed.

- Q. All systems shall be complete true stand-alone systems. Program database, data acquisition, and all control sequence logic shall reside in each DDC Device.
- R. The Building Level Communication Network (BLCN) shall not be dependent upon connection to a Server or Master Controller for the performance of the Sequence of Control as outlined in this Specification. Each Device shall, to the greatest possible extent, perform its programmed sequence without reliance on the BLCN.
1. All devices installed shall be native BACnet. **LonWorks or proprietary protocols are NOT ALLOWED.** Devices that are not BACnet tested, compliant, certified, clearly stamped and listed by the BACnet Testing Laboratories (BTL) shall not be acceptable under this Specification and are strictly prohibited.
 2. System shall be provided with a complete Web-enabled operator interface. The application shall operate on industry standard PC hardware. Proprietary server hardware or "Black Boxes" will not be acceptable. Third party Web-enabled applications are acceptable if they are configured to be indistinguishable from the OWS applications.
 3. No Gateways, Communication Bridges, Protocol Translators or any other device that translates any proprietary or other communication protocol to the BACnet communication the protocol shall be permitted as a part of the EMCS installation under this Specification section. Gateways may only be used as required for communication to existing systems or systems installed under other Specification sections.
 4. All EMCS DDC Devices shall be capable of updating firmware using software via the internet without replacing any hardware, microprocessors or chips.
 5. Installed system must have full access to logic and functional blocks. User shall have full ability to modify programming.
 6. Outside air temperature shall be supplied by the National Weather Service with a local backup at every site.
 7. Point naming/labeling shall be consistent throughout buildings.
 8. Where Drawings are provided as part of or supplement to these Specifications, such Drawings are inherently schematic only and not intended to convey all controls, wiring, installation, details, etc. It shall be the responsibility of the EMCS Contractor to verify that control approaches presented are appropriate for the HVAC systems involved, and that bids include all work described, specified, or otherwise necessary for a complete and functioning system.
 9. System shall have the ability to program schedules locally if needed during network outages.

1.2 RELATED DOCUMENTS & REFERENCES

- A. Drawings and general provisions of the contract documents, apply to this section including:
1. Division 01 for General Conditions and Supplementary Conditions.
 2. Division 21 for fire protection equipment.
 3. Division 22 for plumbing equipment and domestic water systems.
 4. Division 23 for mechanical equipment, ductwork, and piping systems.
 5. Division 26 for electrical equipment, lighting control, and fire alarm systems.
 6. Section 013300 Submittals.
 7. Section 01524 Construction Waste Management
 8. Section 01352 LEED Requirements
 9. Section 01611 Environmental Management
 10. Section 01570 Pollution Prevention and Control
- B. The latest edition of the following standards and codes in effect as approved by the authority having jurisdiction and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:
1. ANSI MC85.1 - Terminology for Automatic Control.
 2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

3. ANSI/ASHRAE Standard 135-2016, BACnet.
4. BTL Mark by the BACnet Testing Laboratories.
5. International Building Code (IBC), 2015 edition including local amendments.
6. International Energy Conservation Code (IECC), 2015 edition including local amendments.
7. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
8. National Electrical Code (NEC), 2017 edition.
9. FCC Part 15, Subpart J, Class A.
10. National Institute of Standards and Technology (NIST).
11. IEEE STD 802-2014: IEEE Standard for Local and Metropolitan Networks, Overview and Architecture.

1.3 RELATED WORK IN OTHER SECTIONS

- A. Refer to Division 00 and Division 01 for allowances and related contractual requirements.
- B. Refer to Division 21 for General Fire Protection Provisions and fire suppression pump.
 1. The EMCS Contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP or Modbus acceptable if IP interface is not available from equipment manufacturer.
 2. The EMCS Contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.
- C. Refer to Division 22 for General Plumbing Provisions, domestic water heating systems, domestic water pumping systems, and domestic water metering.
 1. The EMCS Contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP or Modbus acceptable if IP interface is not available from equipment manufacturer.
 2. The EMCS Contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.
- D. Refer to Division 23 for General Mechanical Provisions for equipment such as air-handling units, terminal units, ventilation fans, variable frequency drives, unitary AC units, etc.
 1. The EMCS Contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP or Modbus acceptable if IP interface is not available from equipment manufacturer.
 2. The EMCS Contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.
- E. Refer to Section 26 for General Electrical Provisions for equipment such as electrical switchgear control, electrical power monitoring, emergency generators, lighting control system, etc.
 1. The EMCS Contractor shall provide communications integration via BACnet/IP interface to each installed system listed above. BACnet MS/TP or Modbus acceptable if IP interface is not available from equipment manufacturer.
 2. The EMCS Contractor shall coordinate with all vendors providing above systems to obtain communications requirements and points lists. Map all available points to EMCS.

1.4 ELECTRICAL POWER PROVISIONS

- A. Primary power will be provided under Division 26 by the electrical Contractor to the panel locations indicated on the mechanical & electrical Drawings. Provide step down transformers within panel enclosures. Provide all necessary fuses and circuit protection devices.
- B. Power will be provided to the controllers serving fan powered terminal units with electric heat via the control transformer provided with the unit.

- C. All components of the EMCS shall be powered from the sources above. Provide final terminations from the locations indicated on the Division 23 Drawings.
- D. The EMCS Contractor shall provide any additional control power that is required as part of this contract and not indicated by other. This shall include all conduit, cabling, circuit breakers, etc.

1.5 CONTRACTOR QUALIFICATIONS

- A. The EMCS Contractor shall:
 - 1. Have a local office within 100 miles of jobsite before bid date and at a minimum until the completion of the warranty period.
 - 2. Have a local staff of trained personnel capable of giving instructions and providing routine and emergency maintenance on the EMCS, all components and software/firmware and all other elements of the EMCS.
 - 3. Have a proven record of experience in the supply and installation of equivalent EMCS/BACnet systems over a minimum period of five years. Provide documentation of at least three equal and complexity, if so requested by the Owner's Representative.
 - 4. Be a factory certified representative of the native BACnet EMCS manufacturer for design, installation, and service of the proposed system.
 - 5. Have comprehensive local service, training and support facilities for the total EMCS as provided. Maintain local, supplies of essential expendable parts.
 - 6. Have a local 24/7 phone support service.

1.6 SUBMITTALS

- A. All documents submitted shall be in native pdf format. Scans are not acceptable.
- B. Shop Drawings:
 - 1. The following information shall be included on the cover page for each shop drawing and equipment documentation submittal:
 - a. Project name with date. Refer to the applicable Specifications by name and number.
 - b. Provide submittal number and re-submittal number and date as applicable.
 - c. Provided name and address of Consulting Engineer, Mechanical Contractor, General Contractor
 - 2. Shop drawings shall be CAD generated, plot size of 8-1/2" x 11" or 11" x 17". Drawings shall include diagrams, mounting instructions, installation procedures, equipment details and software descriptions for all aspects of the system to be installed.
 - 3. Provide schematic of systems indicating instrumentation locations, all interconnecting cables between supplied cabinets on a mechanical floor plan.
 - 4. Software specifications and descriptions including operating sequences.
 - 5. Provide a bill of material that indicates specific manufacturer, part number, part description and quantity of each device for all system components.
 - 6. Provide a list of the wire labels to be installed on each end of the control wiring, at the device and the control panel terminal. Labels shall be machine generated, typed and legible with a maximum of 17 characters. The label description "AHU-1 SAT" shall indicate the supply air temperature of AHU-1.
 - 7. Equipment Schematic: Provide an electronic equipment schematic for each piece of mechanical equipment. The schematic shall display all mechanical equipment
 - 8. characteristics including fans, dampers, valves, sensors and other applicable control devices. The schematic shall show wiring terminations to each control device as shown in the submittal and as-build documentation. Control devices shall be labeled by a symbol that can easily be identified in a bill of material that is shown on this graphic. The bill of material shall show the device symbol, description, manufacture and part number.
 - 9. Sequence of Operations: The control sequences shall be viewable for each piece of mechanical equipment and be in a text format as shown in the as built documentation. The

- sequence of operations shall be selectable at the applicable location for the control program.
10. Provide detail points list on every piece of equipment.
 11. Provide technical cut sheets showing all relevant devices and/or information highlighted to distinguish what was installed.
- C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
- D. Control Component Submittals:
1. Component technical data sheets with mounting and installation details.
 2. The documentation shall include comprehensive and complete details of the BACnet Interoperability Building Blocks (BIBB) and automation level documentation including address, associated controller type, etc. as required and for the interface to the EMCS.
 3. Details of networks/communications equipment, cabling and protocols proposed. Provide schedule of cabling including details of proposed cable types.
 4. Module Drawing: Provide an electronic wiring diagram of each control module (as shown in submittal documentation). Diagram shall display wiring schematic and terminations to end devices. Diagram shall display each input and output terminals and label those that are used for the control application. Diagram shall display module type/name and network address.
 5. Field sensor and instrumentation Specification sheets. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.
 6. Schedule and Specification sheets for dampers, valves and actuators.
 7. Design and provide layout of all components of panel mounted control devices, terminal strips and power supplies.
- E. Color Graphics: Provide sample layout of color graphic representations of the systems for review. The submittal shall indicate the quality of the graphic to be provided with the system with a sample of the specific control points to be included. Control points shall as a minimum include points

indicated in the input/output summary, control schematic and primary controlling points defined in the sequences of operation. Provide a sample of a floor plan layout, typical AHU, terminal unit, outside air pretreatment unit, variable frequency drive, exhaust/supply fan, chiller plant and hot water plant. For control points to be provided by equipment BACnet integration provide sample of the control points.

- F. Verification Reports. The submittal shall include a sample of the verification reports to be utilized during the verification section of this Specification. Sample reports shall be approved as submitted or be modified by the engineer or Owner's representative. The verification reports shall be included in the final Operation & Maintenance Manuals. Reports shall be provided in electronic PDF format.
1. Project Systems Verification Form for each controller.
 - a. General information for each form shall include: project name; associated equipment with mark number; control panel number and location; controller number and model number; controller device instance number (address); MS/TP LAN segment number; verifying technician and date.
 - b. Each connected control point and device shall contain the following columns with a separate line for each connected physical point: point description (same as device label); input/output number for each connected control device (AI-XX, AO-XX, DI-XX, or DO-XX).
 - c. Check boxes confirming that the verification tasks have been completed: device location, proper termination at device; proper termination at control panel; sequence is verified; point trend is enabled.
 - d. Data entry boxes indicating measured/confirmed values: preliminary control point value on the graphic; observed control point value; calibration or adjustment value to correct offset; final displayed point value on the color-graphic; date of verification; engineer or Owner's representative verification.
 2. Control Panel Verification Form for each control panel.
 - a. General information: panel location and identification number; panel dimensions and NEMA rating; panel properly installed; Class 1 and Class 2 wiring are properly separated; correct voltage to the panel; no shorts or grounds in panel; no induce voltages in panel wiring; point to point termination match submittal; devices are mounted in the correct location; controller software revision number; address of controllers; panel device checkout is complete; panel startup is complete.
 3. Sequence of Operation Verification Form per piece of equipment (AHU, VAV, chiller, boiler, etc.).
 - a. General information: project name; system identifier; building area served; control panel and controller numbers; controller model number and instance number (address); MS/TP LAN segment number; name of verifying technician and date.
 - b. Each step of the sequence of operation for each piece of equipment shall be documented shall include a "description of test", "input to trigger test" and "expected outcome". A pass/fail checkbox shall indicate each of these actions. Provide space for technician approval with associated date.
- G. Operating and Maintenance (O&M) manuals: Provide O&M manual with full information to allow the Owner to operate, maintain and repair installed products. Include trade names with model numbers, color, dimensions and other physical characteristics.
1. Format: Produce on 8-1/2 x 11-inch pages, and bind in 3-ring/binders with durable plastic covers. Label binder covers with printed title "OPERATION AND MAINTENANCE MANUAL", title of project, and subject matter and "Number _ of _" of binder. Provide substantial dividers tabbed and titled by section/component number.
 2. Table of Contents for each volume:
 - a. Part 1: Directory with name, address and telephone number of Designer, Contractor and Subcontractors and Suppliers for each Project Manual section.

- b. Part 2: Operation and maintenance instructions, arranged by Project Manual Section number where practical and where not, by system. Include:
 - 1) Product design criteria, functions, normal operating characteristic and limiting conditions. Installation, alignment, adjustment, checking instructions and troubleshooting guide. Operating instructions for start-up, normal operation, regulation and control, normal shutdown and emergency shutdown. Test data and performance curves.
 - 2) Spare parts list for operating products, prepared by manufacturers including detailed drawings giving location of each maintainable part, lists of spares recommended for user- service inventory and nearest source of in-stock spares.

H. Record Documentation:

- 1. Details of all alarm, diagnostic, error and other messages. Detail the Operator action to be taken for each instance.
- 2. Detail special programs provided and provide a complete programming instruction manual. Detail operation of all software applications.
- 3. Detailed list of the database for all installed devices.
- 4. Record drawings shall be CAD generated and shall include final locations and point ID for each monitored and controlled device.
- 5. In addition to the required hard-copies, provide electronic copies on a USB Drive with all of the record documentation in PDF format and a USB Drive containing backup copies of all installed software and graphics.
- 6. Provide an excel spreadsheet for tracking and maintenance by equipment type. Coordinate with Owner for database and template requirement.
- 7. Online as-built documentation: provide digital replications of as-builts that shall be accessible from each equipment graphic controlled or monitored by the EMCS.

1.7 WARRANTY

- A. Warranty work and the equipment provided under this contract shall be for a period of one (1) year from the date of Substantial Completion. Warranty shall cover all components, system software, parts and assemblies supplied by this Contractor and shall be guaranteed against defects in materials and workmanship for one (1) year from the date of Substantial Completion. If manufacturer warranty on a product is longer than (1) year, Contractor is responsible for honoring and coordinating the warranty of that product up to the end of manufacturer warranty. Labor to troubleshoot, repair, reprogram or replace system components that have failed due to defects in materials and workmanship shall be provided by this Contractor at no charge to the Owner during the warranty period. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software. All warranty work shall be performed by the EMCS Contractor's local service group.
- B. Warranty shall not include routine maintenance, e.g., equipment cleaning, mechanical parts lubrication, pilot lamp replacement, operational testing, etc. Warranty shall not cover repair or replacement of equipment damaged by under- or over-voltage, misuse, lack of proper maintenance, lightning, water damage from weather or piping failure.
- C. Hardware and software personnel supporting this warranty agreement shall provide on- site or off-site service in a timely manner after failure notification to the EMCS Contractor. The maximum acceptable response time to provide this service at the site shall be 24 hours, during normal working hours.

1.8 OPERATOR WORKSTATION (OWS)

- A. The Operator Workstation shall be any personal computer, connected to the WAN/LAN, with appropriate web browser software installed.

1.9 ENGINEERING WORKSTATION (EWS)

- A. The Engineering Workstation shall be any personal computer or virtual pc and/or server, connected to the WAN/LAN, with a registered copy of the EMCS Contractor supplied engineering and/or programming software installed. The EMCS Contractor shall provide at least one copy of all required software(s) and files, to enable the Owner complete editing/programming functions of all controllers, graphics, and control logic.
- B. The EMCS shall provide one (1) virtual pc and/or server which is compatible with the performance required by the EMCS Engineering Software. It shall be able to be reached locally and remotely as needed.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 CONTROL SYSTEM

- A. Acceptable Manufacturer

1. Temperature control system: The BMCS system shall be fully integrated through the new operator workstation in compliance with the performance requirements set forth in this Specification. All equipment provided herein shall be required to communicate through a facility wide EMCS workstation by means of full binary interface to maintain operations for school district personnel. Any additional software or hardware required to maintain the integrity of the campus wide system shall be included in the bid price. DDC hardware and software introduced as part of this project shall in no way alter the integrity of the campus wide system.
 2. Temperature control system:
 - a. Manufacturers:
 - 1) Tracer by Trane
 - 2) Automated Logic
 3. Installer is responsible for quality and satisfactory operation of devices, and for overall performance of system. New system shall integrate with existing campus BAS system.
 4. Other manufacturers desiring approval shall comply with Section 01 60 00.
- B. Temperature Control System:
1. Include:
 - a. Temperature sensors.
 - b. Humidity sensors.
 - c. Controllers.
 - d. Switches.
 - e. Relays.
 - f. Dampers.
 - g. Damper operators.
 - h. Thermostats.
 - i. Humidistats.
 - j. Hygrometers.
 - k. Other associated controls required to maintain conditions described in detail on Drawings, together with thermometers, gauges and other accessory equipment.
 2. Provide complete system of wiring and air piping as necessary to fill intent of these Specifications.
 3. Control sequences indicated illustrate basic control functions only.
 4. Provide additional controls required to meet intent of these Specifications and make a complete functional system.
 5. Space temperature and humidity control.
 6. Control of air handling units.
 7. Control of exhaust systems.
 8. Control of cooling systems.
 9. Control of heating systems.
 10. Control panels.
- C. Where electronic sensing is used, furnish amplifier relays and transformer complete with overload protection.
- D. Electrical drawings indicate type of motor control required by equipment.
- 2.5** PRIMARY NETWORK SERVER (PNS)
- 2.6** The EMCS shall be fully integrated and a continuation of Stafford MSD's existing Johnson Controls Server and system without exception. The EMCS Contractor shall either upgrade or provide a new ADX Server as part of this system if the existing server is not fully compatible with new Metasys EMCS being provided. The ADX Server shall utilize the Internet and provide efficient integration of standard open protocols. The ADX Server shall maintain comprehensive

database management, alarm management and messaging services, and graphical user interface as follows:

1. Support an unlimited number of users and up to 5 concurrent users over the Internet/intranet with a standard web browser to access alarms, trend logs, graphics, schedules and configuration data. Access to the PNS shall be password protected utilizing authentication and encryption techniques. An audit trail of database changes indicating user, time stamp, and audit action shall be provided.
2. Enterprise level information exchange using an SQL database and HTML5 formats.
3. Synchronize controller databases, database storage scheduling, control and energy management routines
4. Alarm processing and routing shall include email, SMS text messages and paging as needed by the Owner.
5. HTML5 based help system that includes comprehensive online system documentation.
6. Support of multiple Network Area Controllers (NAC) connected to a Local Area Network.
7. Aggregate data and provide visualization interface and dashboard that includes, but not limited to, graphs, gauges, charts of relevant trends and energy usage.

B. Server Functions

1. It shall be possible to access all Network Area Controllers (NAC) via a single connection to the server through the Ethernet LAN. In this configuration, each Network Area Controller can be accessed from a single user login.
2. The PNS shall provide the following functions, at a minimum:
 - a. The server shall provide complete access to distributed global data. The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
 - b. The server shall include a master clock service for its subsystems and provide time synchronization for all NACs.
 - c. The server shall provide scheduling for all NACs and their underlying field control devices.
 - d. The server shall provide demand limiting control that operates across all NACs. The network server shall be capable of multiple demand limiting programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
 - e. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to NACs. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
 - f. The server shall provide central alarm management for all NACs supported by the server. Alarm management shall include: routing of alarms to a video display, a printer, an email and pager; view and acknowledge alarms; query alarm logs based on user-defined parameters
 - g. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 - h. The server shall provide central management of logged data for all NACs supported by the server. Logged data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include: viewing and printing log data; exporting log data to other software applications; query log data based on user-defined parameters. A report log of manually overridden points shall be part of the management system.
 - i. Storage of the graphical screens shall be in the network web server, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

- j. Modify common application objects, such as schedules, calendars, and set-points in a graphical manner. Schedule times will be adjusted using a graphical slider. Holidays shall be set by using a graphical calendar.
- k. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop- up menu. No entry of text shall be required.
- l. The Primary Network Server shall be capable of supporting at the very minimum the following open system drivers.
 - 1) BACnet/IP
 - 2) Modbus TCP

C. Network Server Platform Requirements

- 1. Rack-Mounted Server Computer Hardware: DELL PowerEdge R230 or equal, Intel Xeon Quad E3-1225 V53.3 GHz or higher, 16GB RAM, 1TB hard drive, video card, 22" color monitor, and Ethernet adapter 1Gbps or higher.
- 2. Operating system software shall be Microsoft Windows 10 Professional or higher. Exceptions shall be pre-approved by Owner.

2.7 NETWORK AREA AUTOMATION ENGINE (NAE)

A. General

- 1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Engines.
- 2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
- 3. User Interface – Each NAE shall have the ability to deliver a web based User Interface using the Site Management Portal functionality previously described. All computers connected physically or virtually to the automation network shall have access to the web based user interface.
 - a. The web based user interface software shall be embedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - b. The NAE shall support a minimum of two (2) concurrent users.
 - c. The web-based user shall have the capability to access all system data through a single NAE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
 - e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - f. The NAE shall have the capability of generating web based user interface graphics. The graphics capability shall be embedded in the NAE.
 - g. Systems that only support user interface graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - h. The web based user interface shall support the following functions using a standard version of Microsoft Internet Explorer:
 - 1) Configuration
 - 2) Commissioning
 - 3) Data Archiving
 - 4) Monitoring
 - 5) Commanding
 - 6) System Diagnostics
 - i. Systems that require workstation software or modified web browsers for system queries are not acceptable.

- j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
 - 4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
 - 5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
 - 6. User Authentication – The NAE shall support local users, Active Directory users, Microsoft Office 365 users and Remote Authentication Dial-in User Service (RADIUS).
 - 7. Password Security – Access to the embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes and the user shall be denied access until permission is renewed by a system administrator.
 - 8. Network Security – Communication between the NAE and other system networked devices including additional Network Engines, Application and Data Servers, Open Data Servers (BACnet listed OWS), and user interface clients shall be encrypted and support HTTPS with Transport Level Security (TLS) Version 1.2. Self-signed certificates are to be provided with the option of configuring trusted certificates.
 - 9. Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.
 - 10. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
 - 11. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
 - 12. Certification – The NAE shall be listed by UL.
 - 13. Controller network – The NAE shall selectively support the following communication protocols on the controller network:
 - a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135 on the controller network.
 - 1) The NAE shall support Remote field bus integration via a BACnet IP to MS/TP router.
 - 2) The NAE shall be BTL certified and carry the BTL Label.
 - 3) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
 - 4) A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
 - 5) The Conformance Statements shall be submitted 10 days prior to bidding.
 - b. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
 - 1) All LonWorks controls devices shall be LonMark® certified.
- B. Network Automation Engine – Large, Dual Trunk
- 1. The NAE shall support a minimum of:
 - a. One Hundred (100) BACnet Standard MS/TP controllers per trunk (200 total).

- b. Two Hundred Fifty Five (255) LonWorks FTT10 Free Topology control devices.
- c. One Hundred (100) N2 control devices per trunk (200 total).
2. The NAE shall include troubleshooting LED indicators to identify the following conditions:
3. Power – On/Off.
 - a. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic.
 - b. Ethernet Connection Speed – 10 Mbps/100 Mbps/1000 Mbps.
 - c. FC Bus A – Normal Communications/No Field Communications.
 - d. FC Bus B – Normal Communications/No Field Communications.
 - e. Peer Communication – Data Traffic between NAE Devices.
 - f. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running.
 - g. Bat Fault – Battery Defective, Data Protection Battery Not Installed.
 - h. 24 VAC – 24 VAC Present/Loss of 24 VAC.
 - i. Fault – General Fault.
 - j. Modem RX – NAE Modem Receiving Data (as required).
 - k. Modem TX – NAE Modem Transmitting Data (as required).
4. Communications Ports – The NAE shall provide the following ports for operation of operator I/O devices, such as industry-standard computers, modems, and portable operator's terminals.
 - a. Two (2) USB port.
 - b. Two (2) RS-232 serial data communication port.
 - c. Two (2) RS-485 port.
 - d. One (1) Ethernet port.
5. Provide Johnson Controls NAE-55XX or approved equal as indicated on plans.

2.8 FIELD EQUIPMENT CONTROLLERS (FEC)

- A. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol or optionally via N2Open.
 1. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135 on the controller network.
 2. The FEC shall be BTL certified and carry the BTL Label.
 3. The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 4. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
 5. The Conformance Statement shall be submitted 10 days prior to bidding.
- B. The FEC shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
- C. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
- D. The FEC shall include troubleshooting LED indicators to identify the following conditions:
 1. Power On.
 2. Power Off.
 3. Download or Startup in progress, not ready for normal operation.
 4. No Faults.
 5. Device Fault.
 6. Field Controller Bus – Normal Data Transmission.
 7. Field Controller Bus – No Data Transmission.
 8. Field Controller Bus – No Communication.

9. SA Bus – Normal Data Transmission.
 10. SA Bus – No Data Transmission.
 11. SA Bus – No Communication.
- E. The FEC shall accommodate the direct wiring of analog and binary I/O field points with the following minimum A/D and D/A conversion resolution.
1. Provide a minimum 15 bit A/D resolution for analog inputs.
 2. Provide a minimum 15 bit D/A resolution for analog outputs.
- F. The FEC shall support the following types of inputs and outputs:
1. Universal Inputs – shall be configured to monitor any of the following:
 2. Analog Input, Voltage Mode.
 3. Analog Input, Current Mode.
 4. Analog Input, Resistive Mode.
 5. Binary Input, Dry Contact Maintained Mode.
 6. Binary Input, Pulse Counter Mode.
 7. Binary Inputs – shall be configured to monitor either of the following:
 8. Dry Contact Maintained Mode.
 9. Pulse Counter Mode.
 10. Analog Outputs – shall be configured to output either of the following:
 11. Analog Output, Voltage Mode.
 12. Analog Output, current Mode.
 13. Binary Outputs – shall output the following:
 14. 24 VAC Triac.
 15. Configurable Outputs – shall be capable of the following:
 16. Analog Output, Voltage Mode.
 17. Binary Output Mode.
 18. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
- G. The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.
1. The FC Bus shall support communications between the FECs and the NAE.
 2. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
 3. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
 4. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
- H. The FEC shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.
1. The SA Bus shall be a MS/TP Bus supporting BACnet Standard Protocol SSPC-135.
 2. The SA Bus shall support a minimum of 10 devices per trunk.
 3. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- I. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
- J. The FEC shall support, but not be limited to, the following applications.
1. Chilled water/central plant applications including but not limited to:
 2. Selection and sequencing of up to eight chillers of different sizes.
 3. Selection and sequencing of up to eight (each) primary and secondary chilled water pumps of varying pumping capacities.
 4. Selection and sequencing of up to eight condenser water pumps.
 5. Selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and Vernier control.

6. Selection and sequencing of up to four heat exchangers, of different capacities.
 7. A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.
 8. The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences.
 9. Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant.
 10. Control definition for the chiller plant in a single FAC, FEC, or NCE, as supported by available memory and point I/O, or capable of being split across multiple FACs, FECs, or NCEs.
 11. Heating central plant applications.
 12. Built-up air handling units for special applications.
 13. Terminal & package units.
 14. Special programs as required for systems control.
- K. The FEC shall support a Local Controller Display either as an integral part of the FEC or as a remote device communicating over the SA Bus.
1. The Display shall use a BACnet Standard SSPC-135 MS/TP protocol.
 2. The Display shall allow the user to view monitored points without logging into the system.
 3. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
 4. The Display shall provide password protection with user adjustable password timeout.
 5. The Display shall be menu driven with separate paths for:
 6. Input/Output.
 7. Parameter/Setpoint.
 8. Overrides.
 9. The Display shall use easy-to-read English text messages.
 10. The Display shall allow the user to select the points to be shown and in what order.
 11. The Display shall support a back lit LCD with adjustable contrast and brightens and automatic backlight brightening during user interaction.
 12. The display shall be a minimum of 4 lines and a minimum of 20 characters per line.
 13. The Display shall have a keypad with no more than 6 keys.
 14. The Display shall be panel mountable.
- L. Provide Johnson Controls FEC or approved equal as shown on plans.

2.9 VAV MODULAR ASSEMBLY (VMA)

- A. The VAV Modular Assembly (VMA) shall provide both standalone and networked DDC of pressure-independent, VAV terminal units. It shall address both single and dual duct applications.
- B. The VMA shall be BTL certified and carry the BTL Label.
 1. The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 2. A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.
 3. The Conformance Statement shall be submitted 10 days prior to bidding.
- C. The VAV Modular Assembly shall communicate over the Field Controller Bus using BACnet Standard protocol SSPC-135.
- D. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications as provided. An externally mounted isolation transformer shall not be acceptable.

- E. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece. Alternate configurations shall be available as follows:
1. A configurable digital controller with integral differential pressure transducer but without a damper actuator – for controlling large VAV boxes that require high torque.
 2. A configurable digital controller with an integral damper actuator but without a differential pressure transducer –for commercial zoning applications or for pressure-dependent VAV box applications.
 3. A configurable digital controller with an integral damper actuator and ball valve linkage but without a differential pressure transducer –for chilled beam applications.
- F. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB or the controller is designed and suitable for use in other environmental air space (plenums) in accordance with Section 300.252(C) of the National Electrical Code.
- G. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
- H. The controller shall determine airflow by a state-of-the-art digital non-flow pressure sensor to provide 14-bit resolution with bidirectional flow operation that supports automatic correction for polarity on high- and low-pressure DP tube connections; this pressure sensor eliminates high- and low-pressure connection mistakes.
- I. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
- J. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
- K. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
- L. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group.
- M. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
- N. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
- O. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
- P. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain (“K” factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

- Q. Controller shall have on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate Exponentially Weighted Moving Averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
1. Absolute temperature loop error.
 2. Signed temperature loop error.
 3. Absolute airflow loop error.
 4. Signed airflow loop error.
 5. Average damper actuator duty cycle.
- R. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
1. Unreliable space temperature sensor.
 2. Unreliable differential pressure sensor.
 3. Starved box.
 4. Actuator stall.
 5. Insufficient cooling.
 6. Insufficient heating.
- S. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
- T. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.
- U. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
- V. Inputs:
1. Analog inputs with user-defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
 2. 0-10 VDC Sensors.
 3. 1000ohm RTDs.
 4. NTC Thermistors.
 5. The AVMA shall provide minimum 15 bit A/D resolution for analog inputs.
 6. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
 7. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
 8. Provide side loop application for humidity control.
- W. Outputs
1. Analog outputs shall provide the following control outputs:
 2. 0-10 VDC
 3. The AVMA shall provide minimum 15 bit D/A resolution of analog outputs
 4. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
 5. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
- X. Application Configuration

1. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.

Y. Sensor Support

1. The VMA shall communicate over the SA Bus with a Network Sensor.
2. The VMA shall support an LCD display room sensor.
3. The VMA shall also support standard room sensors as defined by analog input requirements.
4. The VMA shall support humidity sensors defined by the AI side loop.

- Z. Provide Johnson Controls VMAxx or approved equal as shown on plans.

2.10 AIR HANDLING UNIT CONTROLLER

- A. All devices required for single loop control shall be terminated on a single controller, (for example, AHU static pressure control. The differential pressure sensor and the VFD ramp signal.)
- B. The EMCS Contractor shall provide controllers required for chilled/hot water and DX/electric heat air handling units and fan coil units. Provide an enclosure to house the controller and associated components including suitable mounting brackets shall be NEMA 1 rated and located outside the FCUs.
- C. The controller shall be capable of monitoring and controlling the following parameters per the sequences of operation and input/output summary; space temperature; space relative humidity sensor; cooling/heating stage control or modulating valve control; fan on/off control and status; supply air sensor; occupancy sensor; carbon dioxide sensor; VFD control and monitoring.

2.11 SOFTWARE OVERVIEW

A. Dedicated Web Based User Interface

1. Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. Real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines and Data Server(s) to facilitate greater fault tolerance and reliability.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
 - a. Microsoft Internet Explorer 11.0 or Edge for user interface functions.
 - b. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions.
 - c. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports.
 - d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.
 - e. PC Hardware/Software – The personal computer(s) shall be configured as specified in the Computing Hardware and Software section.
 - f. Provide one operational device as herein specified and located on plans.
3. Mobile, Web Based, User Interface (MUI)
 - a. General
 - 1) The mobile, web based, user interface shall be HTML5-compliant and provide device-agnostic access to the system from smartphones, tablets, portable and desktop computers. User Interfaces that require software installation on

- the client device (e.g. Java, MicrosoftSilverlight®, Adobe® Flash®), or software downloads from an online app store shall not be acceptable for these purposes.
- 2) The mobile user interface shall provide system operators with a simple location-based navigation approach to finding information, including the ability to search for any location by name and to bookmark a location in a standard browser.
 - 3) The mobile user interface shall organize and display information using customer specific locations and spaces. At a minimum, the user interface shall provide:
 - a) Organization of all space, equipment and point information in a familiar way (using standard equipment names and location descriptions), reducing the need for extensive training prior to use.
 - b) A navigation mechanism or tree for users to select the specific location or space for accessing information – only spaces and locations in the navigation tree or equipment serving that space, nothing more.
 - c) The ability to search for and/or bookmark any location, space, or equipment by name for quick access to critical or troublesome areas.
 - d) Application of the same navigation mechanisms across any client device (e.g. Smart phone, tablet, personal computer) for consistency and ease of use.
 - 4) The same user interface elements shall be accessible from any type of personal computer or mobile device running any type of operating system supported (e.g. iOS, Android, Windows®). It shall automatically adapt and optimize the display for the screen size and touch screen navigation.
 - 5) The user interface shall provide support for up to 50 concurrent users from individuals with defined access to the system.
- b. Navigation Trees
- 1) A dedicated location based navigation tree shall be provided as part of the user interface in order to navigate to specific places within the facility on a hierarchical basis (typ. Facility, Building, Wing, Floor, Room.)
 - 2) The location-based tree shall use place names familiar to the operator without training or familiarization regarding special codes and conventions utilized in the generation of the BMS.
 - 3) Clicking or tapping on a location name in the tree shall display the home page associated with the space and simultaneously expand the tree to display the next level of spaces below the one selected.
 - 4) It shall be possible for qualified users to view a navigation tree of devices connected to the BMS network in order to enable troubleshooting of equipment and communications. Clicking or tapping on the Network Icon at the top of the Navigation Tree will access this alternate view. Users without the necessary access rights shall not see the Network Icon.
 - 5) A click or tap on a device in the network tree shall display a dashboard for that device including information regarding related equipment and access to a separate focus view of commandable points associated with the piece of hardware. A click or tap on such a point shall display a control dialogue box allowing the user to modify or command that point as indicated. The dialog box shall contain an annotation box for describing why the action was taken or special circumstances that apply.
 - 6) Specific hardware and software types in the Network tree shall also include access to one or more the following views in their dashboard depending on hardware type or network element (e.g. MS/TP trunk):
 - a) Summary View
 - b) Diagnostic View
 - c) Network View

- d) Trend View
- 7) It shall be possible to hide the Network Tree and return to the Spaces Tree at any time by clicking on the Spaces Icon above the tree.
- c. Dashboard Displays
 - 1) The user interface shall provide the ability to view equipment visualizations, floor plans, and/or other graphics on mobile or desktop client devices in a browser environment, without the need for additional plugins or software. Graphics shall be accessible via a space (for floorplans, campus maps, etc.) or equipment dashboard.
 - 2) Standard dashboards shall be configured for each defined space including one of the following predefined or custom elements:
 - a) Equipment Serving Space
 - b) Potential Problem Areas
 - c) Equipment Summary
 - d) Graphic Display (if specified)
 - e) Schedule
 - 3) Standard dashboards shall be configured for each system or device (typ. mechanical or electrical equipment) including the following predefined or custom elements:
 - a) Trend
 - b) Equipment Activity Summary
 - c) Equipment Relationships Summary
 - d) Equipment Data
 - e) Graphic Display (if specified)
 - f) Schedule
 - 4) Users with appropriate permissions shall have access to a Dashboards Manager that can change the display order of Summaries and Data elements, add or remove elements and apply custom dashboards layouts to equipment and space by type.
 - 5) Dashboard Manager shall apply dashboards to spaces or equipment based on the viewing platform (Desktop/Tablet or Phone) in order to tailor the user experience to the needs of the specific user base.
 - 6) Default dashboard displays by space and equipment type shall be created per the guidelines in this specification or by mutual agreement with the owner's representative.
- d. Alarm Management
 - 1) The user interface shall provide a single display of all potential issues in a facility including items currently in alarm, warning, override, out-of-service and offline.
 - 2) The user interface shall provide notification of new alarms, visually and audibly.
 - 3) The user interface shall provide the ability to view a summary of alarms, including a chart of the number of alarms in each of the defined alarm priority ranges. The priority ranges should be filterable.
 - 4) The user interface shall provide the capability to view multiple occurrences of the same alarm, ultimately providing the ability to acknowledge or discard all occurrences of the alarm in a single action.
 - 5) The user interface shall provide the capability to view, and filter on, all alarms present in a well-defined mechanical system using the equipment serving equipment relationships.
 - 6) The user interface shall provide the capability to acknowledge and discard all occurrences of at least 1000 alarms in one operation.
 - 7) The user interface shall provide the user with the understanding of what physical space is being affected when an alarm occurs. The user interface

- shall provide the ability to filter alarms by physical space affected when the alarm occurred.
- 8) The user interface shall provide the capability to monitor alarms 24/7 without requiring an active login to the system, accessible via segregated web page. The user interface shall provide the capability to enable or disable the 24/7 alarm monitor mode if desired.
- e. Equipment Activity Summary
- 1) The user interface shall provide a filterable, single display, of all activity related to a specific piece of equipment including user changes, discarded user changes, pending alarms, discarded alarms, and acknowledged alarms for at least one year of historical data.
 - 2) Items shall be listed in timed order with the latest activity at the top of the list.
 - 3) Filters shall allow only specific activities for specific data points occurring within a specific time and date window to be displayed.
 - 4) It shall be possible to export a .csv copy of the currently displayed summary by clicking or tapping on the export icon.
 - 5) It shall be possible to create a custom trend graph containing the data shown in the currently displayed summary by tapping or clicking on the trend icon in the header bar and selecting the specific points to trend in the resulting selection panel.
 - 6) Clicking on the information icon in front of any displayed activity listed in the summary shall expand the display to include the name of the user, server time, value prior to the activity, the ability to annotate the activity and a user selectable icon for displaying a trend graph of the point.
- f. Equipment Relationships Summary
- 1) The user interface shall provide a summary of all equipment and spaces related to the operation of the system or device currently selected for viewing.
 - 2) Include the capability to navigate to the home page of any related piece of equipment or space with a single click or tap on the desired element.
- g. Equipment Data Summary
- 1) The user interface shall provide a summary of all data pertaining to a particular piece of mechanical or electrical equipment in a tabular format.
 - 2) Clicking or tapping on any value in the summary shall display a related command panel allowing the user to command, override, or change service condition of the point selected and to annotate such actions for future reference.
 - 3) It shall be possible to export a .pdf copy of the report with a single click on the associated export icon.
- h. Equipment Serving Space Summary
- 1) The user interface shall provide a summary of all mechanical and electrical equipment as defined in the points list that serves a selected space from the navigation tree.
 - 2) The summary shall be capable of including a subset of the viewable points for each system representing the key elements of interest to operators without subjecting them to long lists of points irrelevant to basic operation.
 - 3) Clicking or tapping on any item in the summary shall navigate to the item's assigned home page in the user interface.
 - 4) It shall be possible to view a custom trend of information contained in the summary with a single click of the trend icon residing in the title header.
 - 5) It shall be possible to display specific systems and points by filtering equipment types desired.
 - 6) Because the data is intended to be a snapshot of the current conditions in the space it shall not dynamically update but a click or tap on the update icon at any time performs that function.
- i. Potential Problem Areas

- 1) The user interface shall provide a summary of all points in the system related to the space that are not operating correctly (e.g. alarm, off normal or not communicating correctly) in order to provide the operator with a quick update on current conditions.
 - 2) The information shall include:
 - a) Point status (via color.)
 - b) Point name.
 - c) Value of the point when the summary was taken.
 - d) Equipment that contains the offending point.
 - e) Space that is served by that equipment.
 - 3) Data points in the summary may be filtered by one or more types of off-normal condition (e.g. above setpoint, offline and overridden).
 - 4) The summary may be exported in .csv format for inclusion in spreadsheets or other documents.
- j. Equipment Summary
- 1) The user interface shall provide a summary that allows the user to compare all similar equipment that serves the space as well as downstream (child) spaces in order to evaluate conditions quickly and determine patterns for troubleshooting purposes.
 - 2) Each unique equipment type shall be selectable and display a representative set of values along with the space(s) being served by the device. Equipment types can be selected from a dropdown menu in the summary.
 - 3) Clicking or tapping on a selected device in the summary shall navigate to the home page for that piece of equipment while clicking or tapping a data point shall display the command panel for that point.
 - 4) It shall be possible to export a .pdf copy of the currently displayed summary by clicking or tapping on the export icon.
 - 5) It shall be possible to create a custom trend graph containing the data shown in the currently displayed summary by clicking on the trend icon in the header bar and selecting the specific points to trend in the resulting selection panel.
- k. User Defined Summaries
- 1) Provide the capability to view, command, and modify large quantities of similar data in summaries without the use of a secondary application (e.g. a spreadsheet). These summaries shall be generated automatically or user defined. User defined summaries shall allow up to seven user defined columns describing attributes to be displayed including custom column labels with up to 100 rows per summary.
- l. Trend
- 1) The user interface shall provide the capability to view historical trend data from multiple pieces of equipment in both bar and line formats.
 - 2) The user shall have the ability to navigate to a selection list of frequently viewed trends.
 - 3) Trend graphs shall have to ability to be smartly auto-generated based on equipment and space relationships.
 - 4) Each graph shall include a dedicated selection icon to export a copy of the graphic and data in .pdf format or the data only as a .csv file.
- m. Operator Access
- 1) The user interface shall provide the ability to segment access to building data based on the space(s) or location(s) the user is physically located in and/or manages. The user interface shall provide the capability to assign "inherited" space permissions and the ability to assign user's space based access in bulk.
 - 2) The user interface shall provide the ability to segment access to building data based on the space(s) or location(s) the user is physically located in and/or manages. The user interface shall provide the capability to assign "inherited"

- space permissions and the ability to assign user's space based access in bulk.
- n. Graphics
- 1) The user interface shall display an equipment visualization or graphic within the context of its associated space (building, floor, room, etc.) or equipment dashboard.
 - 2) Graphics shall include the ability to define individual information layers for operator selection in order to clarify systems status and simplify operation on mobile devices. Where desired a master layer may be defined to include important information about the facility on all graphic screens.
 - 3) Graphics shall support the use of photo-realistic symbols as well as color change and animation to match the status of the related system control point.
 - 4) It shall be possible to export a time stamped .pdf file of the graphic being viewed in order to communicate the current conditions in the space or the equipment being viewed and to provide a historic record.
 - 5) An integral graphic manager shall be provided including the following features and capabilities:
 - a) Creation and modification of graphics from any HTML5 capable browser without the need for additional plug-ins or software packages.
 - b) Access to a full suite of pre-defined templates for air and water sourced HVAC applications as well as the ability to add custom templates as created for other use. Pre-aliased graphic templates may be defined and saved for repetitive representations of common mechanical and electrical equipment.
 - c) A full suite of pre-defined three dimensional symbols for mechanical and electrical systems as well as all line, text and shape tools required for integration into a graphic with zoom and pan capabilities on multiple platforms and in multiple browsers.
 - d) The ability to search and replace items in multiple graphics with a single command.
 - e) The ability to import and insert photos and images into the graphic.
 - f) The ability of the graphics manager to create and edit graphics including the ability to bind graphic elements to the values and conditions of system points in both an on-line and off-line mode.
 - 6) As required, the BMS Contractor shall provide software licenses in the name of the owner for programming, configuration and graphics building tools to allow designated representatives to make changes, modifications or additions to the system. While future updates or revisions may require an update fee, the owner shall incur no additional cost if they choose not to update. Systems that require any annual or time-limited licensing fees shall not be permitted.
- o. Scheduling
- 1) The user interface shall provide the capability to display, in a singular view, all of the effective schedules in the context of the space (building/floor/room, etc.) or equipment that the schedule effects. The software should have the ability to display an effective schedule, for the present, or a future date.
 - 2) The user interface shall provide a report of all schedules affecting a space or equipment. The report shall provide the user details of events that comprise the weekly schedule and exception schedule(s). The report shall provide a means of viewing individual breakout scheduling elements for Weekly Schedule, Exceptions and Default Commands.
 - 3) The user interface shall provide the capability to efficiently change or modify schedules in mass quantities. This includes the capability to add, in bulk, exceptions to schedules, in addition to assigning, in bulk, weekly schedules.
- p. Command and Control

- 1) It shall be possible to command system analog and binary points via a dropdown menu accessed by clicking or tapping on the value shown in any equipment summary or graphic display and completing the task in the resultant menu including an optional annotation.
 - 2) Commanding multiple points shall be possible on displays where multiple like system elements can be chosen.
- q. Search
- 1) Typing a text string in the Search box shall display a list of all occurrences of that string in the mobile user interface. When a string is represented in the description of a space or network element, selecting it shall display its default dashboard.
 - 2) Clicking or tapping on the Advanced Search Icon shall display the Advanced Search dialog box permitting the following:
 - a) Search by Space and Equipment, Equipment Definition or Network Reference.
 - b) Filter the search by wildcard name or object type.
 - c) Multi-selection of objects for commanding or the creation of reports including Trend, Alarm, Audit and Activity for a specific period of time.
- r. Offline Operation
- 1) The mobile user interface shall have the ability to operate in an offline mode in order to create or edit graphics and dashboard elements.
 - 2) Content created offline shall be available to all authorized users for inclusion of an operating user interface later.

2.12 ENERGY SAVING PROGRAMS

- A. Demand Limiting: Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
- B. Duty Cycling: Periodically stop and start loads, based on space temperature, and according to various on/off patterns.
- C. Automatic Time Scheduling: Self-contained programs for automatic start/stop/scheduling of building loads. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary schedules.
- D. Optimal Start/Stop: Perform optimized start/stop as function of outside conditions, inside conditions, or both. Optimization shall be adaptive and self-tuning, adjusting to changing conditions by modifying occupancy period based upon the desired temperature at beginning and end of the occupancy period. Base optimization on occupancy schedules, outside air temperature, seasonal requirements, and interior room temperature. Employ adaptive model prediction for how long building takes to warm up or cool down under different conditions.
- E. Night-Setback Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours in conjunction with scheduled start/stop and optimum start/stop programs.
- F. Setpoint Reset: Setpoints for control of variable load systems shall be reset based on load demand, as described in the Sequence of Operations.
- G. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
- H. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.

- I. Holiday Scheduling.
- J. Direct Digital Control: Furnish software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
- K. Trend logging shall be provided for all points per the input/output summary where there is a change in the analog or binary signal. Each controller shall be capable of storing trend values and then automatically transfer data to the NAC or the NS hard disk. Trend data shall be updated continuously per the operator assigned interval at intervals as low as one minute. Collect samples at intervals specified in minutes, hours, days, or month. Output trend logs as line-graphs or bar graphs. Binary points (input and output) shall only be logged upon a change of value (COV). Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

2.13 FIELD INSTRUMENTATION

- A. Temperature Sensors: All temperature sensors shall be thermistor type, factory- calibrated to within 1 degree F, interchangeable with housing appropriate for application. Sensors shall have a temperature curve rated for the application. Sensor wiring terminations shall be in a galvanized box.
 - 1. Outside air temperature sensors shall be installed in weather proof enclosure with ventilated sun-shield
 - 2. Duct mounted temperature sensors shall be averaging type for supply air, mixed air and low temperature applications for air handling units. Duct probe temperature sensor shall be acceptable for terminal units.
 - 3. Space temperature sensors shall contain a backlit LCD digital display and user function keys along with temperature sensor, setpoint adjustment and after-hours override use. Override time may be set in one-hour increments.
 - 4. Provide flat plate stainless steel space temperature sensors with no local setpoint adjustment as indicated on the Drawings.
- B. Carbon Dioxide Sensors: The sensor shall be capable of monitoring carbon dioxide concentration with an accuracy of +/- 50 parts per million (PPM). The sensor shall produce a linear 0-10 VDC or 4-20 mA signal over the range of 0 to 2000 PPM. The sensor shall measure using non-dispersed infrared (NDIR) technology to measure carbon dioxide gas and shall be;
 - 1. The EMCS Contractor shall utilize the required calibration devices to properly commission and calibrate the sensors per the manufacturer's requirements.
- C. Relative Humidity Sensors: relative humidity sensors shall be a two-wire type, 4-20 mA output proportional to the relative humidity range of 0-100%. The accuracy of the sensors shall be +2% over a range of 10-90% RH.
 - 1. Outdoor relative humidity sensors: provide non-corroding outdoor shield to minimize wind effects and solar heating. Install wall-mount weather proof enclosure with conduit fitting.
 - 2. Wall-mounted relative humidity sensor: sensor shall be installed in a wall- mounted enclosure with white cover.
 - 3. Duct-mounted relative humidity sensor: sensor shall be provided with a moisture resistant enclosure with conduit fitting. The probe length shall be 8" minimum.
- D. Pressure Transducers:
 - 1. Air pressure sensor: The pressure sensors shall have an input range compatible with the medium being measured. The proportional output signal shall be 0-10 VDC or 4-20 mA.
- E. Freezestat: Provide freezestats for all chilled water air handling systems that receive more than 10% untreated outside air. Freezestats shall provide vapor tension elements, which shall

serpentine the inlet face on all coils. Provide additional sensors, wired in series, to provide one linear foot per square foot of coil surface area. Freezestat shall be manually reset at the switch. Interlock to the associated fan so that fan will shut down when HOA switch is in hand or auto position. Provide time delay relays with a 0-10 minute time delay relay duration to minimize nuisance freezestat trips. Time delay relay shall be adjustable at the associated control panel.

- F. Air differential pressure switch: For fan shutdown, provide air differential pressure switches for all fans controlled by a variable frequency drive (VFD) to shut down the associated fan in the event of sensing high differential pressure. Air differential pressure switches shall have an adjustable setpoint with a range of 0-10 inches W.G. with manual reset at the switch. Provide ¼ inch copper tubing with compression fittings to mount to the side of the duct.
- G. Momentary control relays: Provide momentary control relays as indicated. . Relays shall have coil ratings of 120 VAC, 50 mA or 10-30 VAC/VDC, 40 mA as suitable for the application. Contact ratings shall be 10 amp. Provide complete isolation between the control circuit and the digital output. Relays shall be located in the UC or other local enclosures and have pin-type terminals. Relays shall have LED indication of status.
- H. Current sensing relay: Current sensing relays shall be rated for the applicable load. The output relay shall have an accessible trip adjustment over its complete operating range. Enclosure shall have an LED to indicate relay status.
- I. Photocell: Ambient light level shall be by a photocell in a non-corroding in a weatherproof housing with sun shield suitable for exterior installation. The control signal output shall be 4-20 ma or binary contact closure as specified in the sequences of operation. Mount the photocell on the north side of the building on the roof. The sensor reading shall be 0- 750 foot-candles.
- J. Occupancy Sensors
 - 1. The dual-technology occupancy ceiling mounted sensor shall be capable of detecting presence in the control area by via Doppler shifts in transmitted ultrasound and passive infrared (PIR) heat changes. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off. The sensor shall operate at 24 VDC/VAC.
 - 2. Sensors shall have a time delay that is adjustable with configuration software or shall have a fixed time delay of 5 to 30 minutes, set by a DIP switch. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
 - 3. The sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options. The sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled.

2.14 WHOLE BUILDING METERING

- A. Buildings are to monitor electrical, water and gas usage. Any additional sub metering is to be provided by the Contractor and determined by each specific project as called out on the Drawings or Specifications.

2.15 AIRFLOW MEASURING STATIONS (AFMS)

- A. Duct mounted airflow measuring stations with combination airflow and air temperature measurement devices shall have the following features:

1. Multi-point sensors in one or more probe assemblies with a maximum of one to sixteen sensor nodes per location, and a single remotely mounted microprocessor-based transmitter for each measurement location. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Each sensing point shall independently determine the airflow rate and temperature at each node, which shall be equally weighted in calculations by the transmitter prior to output as the cross-sectional average. Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Each independent temperature sensor shall have a calibrated accuracy of $\pm 0.14^{\circ}\text{F}$ (0.08°C) over the entire operating temperature range of -20°F to 160°F (-28.9°C to 71°C), and be calibrated at 3 temperatures against standards that are traceable to NIST. Acceptable manufacturer shall be EBTRON, Inc. GTx116-PC.
2. Each transmitter shall have a display capable of simultaneously displaying both airflow and temperature. Airflow rate shall be field configurable to be displayed as velocity or volumetric rates, selectable as IP or SI units. Each transmitter shall operate on 24 VAC and be fused and protected from over voltage, over current and power surges.
3. Each independent airflow sensor shall have a laboratory accuracy of $\pm 2\%$ of reading over the entire calibrated airflow range of 0 to 5,000 fpm (25.4 m/s), and be wind tunnel calibrated at 16 points against air velocity standards that are traceable to NIST.

2.16 DAMPER ACTUATORS

- A. Outside and exhaust air damper actuators shall be mechanical spring return. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
- B. Outside and return air modulating actuators shall utilize analog (proportional) control 0-10 VDC. Actuators shall be driven in both the open and closed directions.
- C. Electric damper actuators shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.
- D. Single section dampers shall have one electronic actuator direct shaft mounted.
- E. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section.
- F. Damper actuators shall be BELIMO or equivalent.

2.17 PANELS AND ENCLOSURES

- A. Provide panels and enclosures for all components of the EMCS, which are susceptible to physical or environmental damage.
- B. Interior panels and enclosures shall meet be NEMA 1 rated painted steel panels with locking door.
- C. Exterior mounted panels and enclosures shall be NEMA 4 painted steel panels with locking door.
- D. Panels for USCs shall be mounted on the outside of all unit ventilators and fan coil units with three feet of wall clearance in front of them and no higher than 7 feet to the bottom of the panel.

2.18 LABELING AND WARNING NOTICES

- A. Provide labeling for all control panels and enclosures.

- B. Provide labeling of all control wires and input/output points at the controller and at the control device; the label at each end of the wire shall be the same. Labels shall be machine generated, typed and clearly legible with a maximum of 17 characters. Handwritten labels or labels written on the control wire jacket will not be acceptable. Each label shall be unique to its function and shall reference the applicable system. For example:
 - 1. "AHU-1 SAT" will indicate the supply air temperature sensor for AHU-1. Improper labeling shall be removed and shall require re-commissioning of the control device and controller to document correct functionality.
- C. Provide high voltage warning notices at all equipment controlled by the EMCS and at all associated motor starters when used by equipment controller.

2.19 TUBING AND PIPING

- A. Provide tubing and piping as required for the field instrumentation.
- B. Tubing within equipment rooms, vertical risers, and penetrations to ductwork shall be either copper pipe or shall be plastic tubing within conduit. Tubing for all water-based instrumentation shall be copper pipe. Identify the type of tubing proposed in the shop drawing submittal.
- C. Provide suitable bulk head fittings for duct and panel penetrations.
- D. Tubing in plenum rated areas may be plastic tubing. Polyethylene tubing shall meet, at minimum, the following requirements: flame retardant; crack resistant; 300 psi burst pressure.

2.20 CONDUIT AND FITTINGS

- A. Provide all conduits, raceways and fittings for the EMCS monitoring, communication and control cabling. All work shall meet all applicable codes.
- B. Conduit, where required, shall meet, the requirements specified within Division 26.
- C. EMCS monitoring and control cable shall not share conduit with cable carrying voltages in excess of 90 VAC.
- D. Conduit and fittings must be rated for exterior/outdoor conditions.

2.21 CABLING

- A. Provide all cables for the EMCS. Cable shall meet, at minimum, the following requirements:
 - 1. Minimum 98% conductivity stranded copper.
 - 2. Proper impedance for the application as recommended by the EMCS component manufacturer.
 - 3. Monitoring and control cable shall be #18 AWG or larger, dependent on the application. Analog input and output cabling shall be shielded.
 - 4. Management Level Network cable shall be CAT 6, 24 gauge unshielded.
 - 5. Automation Level Network cable shall be #24 AWG shielded.
 - 6. Shield shall be grounded at the CCP, UC, or control panel. Ground at one end only to avoid ground loops.
 - 7. Identification of each end at the termination point. Identification should be indicated on and correspond to the record drawings.
- B. 120 VAC power wiring shall be of #12 AWG solid conductor or larger as required.

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION

- A. The EMCS supplier shall provide a pre-construction coordination meeting with the affected trades to ensure a cooperative efficient process of installation. The invited trades shall include the general Contractor, mechanical Contractor, electrical Contractor, test and balance Contractor, Owner's representative, consulting engineer and others with a direct interest in the coordination of the affected systems. The EMCS Contractor shall provide an outline of the meeting agenda highlighting the construction schedule, coordination with mechanical and electrical trades. Provide a sign-in sheet and submit it through the attendees along with a summary of the meeting notes for future reference.

3.2 INSPECTION DURING INSTALLATION

- A. Provide a technician to assist the Engineer or Owner's Representative, Test and Balance and Commissioning Agent with inspections made during the installation period that are required to review the progress and quality of ongoing work. The Engineer/Owner's representative shall generate field observation reports on the findings of the inspection. The engineer or Owner's representative shall advise the EMCS Contractor during the inspection of any concerns noted with respect to the installation and shall repeat the concerns in writing as soon as possible after the inspection is completed. The EMCS Contractor shall take corrective action to meet the requirements of the Specifications. Upon correction, the EMCS Contractor shall submit written documentation through the contractors to the engineer.

3.3 INSTALLATION OF COMPONENTS

- A. Provide all interlock and control wiring. All wiring shall be installed in a neat and professional manner in accordance with Specification Division 26 and all national, state and local electrical codes.
- B. Provide wire and wiring techniques recommended by equipment manufacturers. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the Owner's Representative prior to rough-in. Provide auxiliary pilot duty relays on motor starters as required for control function.
- C. Electrical Contractor shall provide 120 or 277 volt power at a junction box within 48" of the controller. The EMCS Contractor shall coordinate with the Electrical Contractor to identify locations of power requirements prior to the installation of the controls.
- D. Conduit for control wiring shall be provided whenever one of the following conditions exists:
 - 1. Conduit is indicated on the Drawings or specifically required by the Specifications.
 - 2. Cabling runs through inaccessible areas such as within partitions/walls, above closed in ceilings, under floor; within trenches and underground; on the exterior of the building; exposed on the surface of the building; when encased in concrete or other material that makes the cable inaccessible or when located such that access to the cable is not readily obtained.
 - 3. Cable within mechanical, telecommunications and electrical equipment rooms and control rooms.
 - 4. Conduit shall be installed, inside wall from sensor box to above the wall, for all wall mounted temperature, humidity and CO₂ sensors.

- E. Control wiring located above an accessible ceiling space may be plenum-rated cable. Plenum rated wire shall be bundled and routed at right angles to the building lines and secured to the building structure every 15 feet.
- F. When communication bus enters or exits a building, a surge suppressor shall be installed. The surge suppressor shall be installed according to the controls manufacturer's instructions.
- G. Provide sleeves for all cable and conduit passing through walls, partitions, structural components, floors and roof
- H. All sensor wiring shall be labeled to indicate the origination (at the device) and destination of data (at the control panel). The description shall indicate the type and location of the control device such as "AHU-1 SA temp" or "VAV 1-1 space temp".
- I. Wall temp sensors at 48" above the finished floor to comply with ADA requirements and to match the height of the light switches. Mount humidity sensor at equal height to wall temperature sensor.

3.4 VERIFICATION REQUIREMENTS

- A. Verification shall be provided by the EMCS Contractor to demonstrate and confirm that the installed system complies with the Specifications and the control sequences of operation herein specified. Upon completion of the verification process the EMCS Contractor shall demonstrate to the Engineer or Owner's representative and Commissioning Agent the functionality of the control system devices are in compliance with the Contract Documents.
 - 1. The installing contractor shall perform a complete Performance Validation (PV) of the Building management system three (3) times throughout the project:
 - a. At project turnover to customer.
 - b. At six (6) months of project operation.
 - c. At twelve (12) months of project operation or end of warranty.
 - 2. Performance Verification shall include a complete and current Building Automation System site inventory including the following information at a minimum: a listing of all field and supervisory controllers with the following key attribute data; corresponding model numbers, firmware versions, available security updates, CPU and memory performance data, battery conditions, integrations, controlled equipment, and device and point counts.
 - 3. Performance Verification shall include a complete written evaluation of system configuration and performance in the following categories:
 - a. Security – The Security evaluation shall include information about controllers that require security updates and conformance of user accounts to latest security rules and best practices.
 - b. Energy Performance – The Energy Performance and Savings evaluation shall identify opportunities through schedule and nightly setbacks, economizers, eliminating simultaneous heating and cooling and adding VSD to equipment.
 - c. Comfort and Health – The Comfort and Health evaluation shall identify temperature, pressure, and carbon dioxide values that deviate from desired set points that could lead to occupant discomfort.
 - d. Reliability – The Reliability evaluation shall identify overridden control points, control points creating excessive alarms, and opportunities to adding control points and trends to further enable system functionality.
 - e. Standards – The Standards evaluation shall identify conformance to published standards for point count, network performance and protocol standards.
- B. Technicians provided by the EMCS Contractor shall be factory trained and qualified in the operation of the provided control system. The EMCS Contractor shall provide, if requested, the factory training certificates of the individuals providing the verification services on this project.

- C. Verification tools, applicable to the system provided, shall be utilized by the factory- trained technicians for proper verification of system operation and functionality. Temperature verification sensors shall be NIST certified within the last 12 months. Meters such as Fluke 52 series or better shall be utilized. Use of non-certified meters may require the system to be re-verified with certified meters at no cost to the Owner.
- D. Documentation of the verification process shall be provided per the project general conditions in electronic PDF format as required. Documentation shall include the following forms:
 - 1. Project System Verification Forms for each controller provided on the project to verify the proper function of each controller, control device and system component provided.
 - 2. Panel Verification Forms for each control panel to document the proper installation and function of each control panel provided.
 - 3. Sequence of Operation Verification Forms for each piece of controlled equipment to confirm compliance of the control system with the specified sequences of operation.
 - 4. Not providing proper documentation for each control devices, panel, or system, upon request by the engineer or Owner's representative, may require the EMCS Contractor to re-verify the applicable systems at no additional cost to the Owner.
- E. After completion of the verification, the EMCS Contractor shall be able to demonstrate the sequence of operations for each system to the engineer and the Owner's representative.
- F. Equipment checkout sheets are to be produced by this Contractor showing checkboxes and compliance with the following procedures for each piece of equipment and turned over to the Owner and/or Mechanical Engineer.

3.5 COLOR GRAPHICS

- A. The color graphics shall be provided for the EMCS system prior to system acceptance and Owner training. Owner has final approval and decision on all graphic templates.
- B. The color graphics provided shall include the following as a template. Provide forward and backward links on the graphic.
 - 1. Site plan with link to overall building plan including detached buildings. The site plan shall be referenced to an automatically updated aerial view or map view of the area such as Google Maps or Bing Maps. Provide link to proceed to the overall building floor plan.
 - 2. The overall building plan shall indicate space temperature conditions referenced by the color of the zone. Specific details of the zone temperatures and equipment are not required. Provide a link to the floor plan wings, upper floors and remote buildings.
 - 3. The floor plan color graphics shall indicate the space temperatures by color references. Additional information shall indicate the space temperature, the occupancy of the zone, air handling units, VAV terminals and ductwork with diffusers. A link at each terminal unit or AHU shall automatically connect the system operator to the equipment color graphic.
 - 4. The color graphics for the equipment shall as a minimum be equal to the points from the input/output summary or control schematic. Primary control devices as required by the sequences of operation shall also be provided.
 - 5. Control points from equipment that are integrated into the EMCS via BACnet shall be provided to convey the operating conditions of the attached equipment. Coordination of the integration points shall be accomplished during the submittal phase. The EMCS Contractor shall provide a list of all integrated points on their submittal.

3.6 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Startup testing documentation: Prepare the checklist documenting startup testing of each input and output device, with technician's initials and date certifying each device has been tested and calibrated prior to acceptance testing. This document shall indicate proof that the following

functions have been commissioned and shall be included in the as-built documentation: short to ground check, configuration of trends, confirmation that color-graphics are accurately representing actual systems, point to point checkout, all damper and valve actuators respond to input change, control modules are addressed and have functional descriptors, specified interlocks are functional, calibration report of all sensors, discrete outputs respond to time schedule or manual enable command.

- B. Demonstration. Prior to acceptance, demonstrate the following performance tests to demonstrate system operation and compliance with the Specifications.
1. Engineer, Owner's representative and mechanical Contractor shall be invited to observe and review system demonstration. Provide attendees at least 10 day's notice.
 2. Demonstration shall follow process approved as part of the submittal and shall include complete checklists and forms for each system as part of system demonstration.
 3. Demonstrate actual field operation of each sequence of operation as specified. Demonstrate calibration and response of any input and output points requested by engineer or Owner's representative.
 4. Demonstrate complete operation of operator interface including review of color-graphics, time schedules, trend logs, alarm notification, functionality of tablet PC operation.
 - a. PID loop response. Supply graphical trend data output showing each PID loop's response to a set point change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be selectable from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show set point, actuator position, and controlled variable values.
 - b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand limiting setpoint, and status of set points and other affected equipment parameters.
 - c. Trend logs for each system. Trend data shall indicate set points, operating points, valve positions, and other data as specified. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.
 5. Alarms and Interlocks. Check each alarm with an appropriate signal at a value that will trip the alarm. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction. Alarm verification shall include temperatures exceeding alarm threshold (high and low), fan failure safety, duct high static pressure switch, freezestat, and smoke detector shutdown.
 6. Tests that fail to demonstrate proper system operation to the engineer shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
- C. Owner Acceptance.
1. After tests described in this Specification are performed to the satisfaction of both Engineer and Owner's representative and Commissioning Agent, the Engineer shall accept the control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond EMCS Contractor's control. Engineer shall provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
 2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved by the Engineer, Owner and Commissioning Agent (CxA).
 3. No portion of the total Contract will be declared substantially complete until the automatic temperature control system has been demonstrated to be complete and functioning as intended. The temperature control system will be complete and functioning as intended when all of the space temperatures are maintained at plus or minus two (2) degrees F of setpoint.

3.7 DEMONSTRATION AND OWNER TRAINING

- A. Provide a training session for the Owner's operations personnel. Training session shall be performed by a qualified person who is knowledgeable in the subject system/equipment. Submit a training agenda two (2) weeks prior to the proposed training session for review and approval. Training session shall include at the minimum:
 - 1. Purpose of equipment.
 - 2. Principle of how the equipment works.
 - 3. Important parts and assemblies.
 - 4. How the equipment achieves its purpose and necessary operating conditions
 - 5. Most likely failure modes, causes and corrections.
 - 6. On site demonstration that includes hands-on demonstration of the manipulation of setpoints, schedules and other adjustable elements of the system.
 - 7. The demonstration shall be on the actual, completed graphic interface pages for the specific project.
- B. Provide a second training session six (6) months after initial session for any follow-up or additional training requested by Owner's personnel. Allow three (3) hours for the second training session.
- C. EMCS Contractor shall provide ongoing free classroom training at their local office for Stafford MSD.

PART 4 - I/O POINTS

4.1 GENERAL

- A. The sequences of operations indicated on the Control Drawings shall be accomplished by the EMCS. Coordinate with Owner in operating equipment to maximize comfort and economy. All points required to accomplish the sequences shall be provided and connected to the EMCS.
- B. Equipment interfaces are acceptable for providing information but each piece of equipment (including but not limited to chillers, VFD's, unitary equipment, etc.) shall have a hardwired point for start/stop and speed control.
- C. All Points added by Engineer and/or Control Contractor needed for the sequences shall be identified in the Submittals and Project Record Documents.
- D. All VFD's and actuators shall have feedback that reports to the EMCS.
- E. All units to have economizer sequences and economizer fault detection and diagnosis capabilities.
- F. Flow meters at air handlers shall be integrated into the EMCS.
- G. Interlock of fire suppression in IT spaces is required and shall be fully coordinated by the EMCS and Fire Suppression Contractors. BACnet interface to be provided by Fire Suppression Contractor for items installed by that contractor.

4.2 BUILDING METERING

- A. I/O Points Lis
 - 1. Electrical Switchgear – Modbus Integration
 - 2. Domestic Water Meter – AI (Domestic Flow Meter by Plumbing Contractor)
- B. Natural Gas Meter – AI (Natural Gas Meter by Plumbing Contractor)

4.3 BUILDING SHUTDOWN (SHELTER IN PLACE)

- A. I/O Points List
 - 1. Shutdown switch status – dry contact - DI
- B. A maintained mushroom type emergency local override button shall be installed in the principal's office or the administration area shall shut down the HVAC system in case of emergency. Once pushed the button must be reset to allow the HVAC system to resume normal operation. The final location of the building shutdown is to be determined by Stafford MSD personnel

4.4 IRRIGATION CONTROL

- A. I/O Points List
 - 1. Monitor and display current flow showing gallons per minute - AI
 - 2. Monitor total gallons used (trend) - AI
- B. EMCS system will interface with irrigation controller to allow owner to control scheduling and zoning of irrigation.

4.5 DOMESTIC WATER HEATING CIRCULATION PUMP

- A. I/O Points List
 - 1. Start/stop – DO
 - 2. Return water temperature – AI
 - 3. Status

4.6 VARIABLE AIR VOLUME BOX WITH SUPPLEMENTAL HEAT

- A. I/O POINTS
 - 1. Space temperature sensor – AI
 - 2. Electric heating coil - AO
 - 3. Cooling damper - AO
 - 4. Fan status – DI
 - 5. Fan speed (hi/lo) - DO
 - 6. Discharge air temperature –AI
 - 7. Space occupancy sensor – DI

4.7 EXHAUST FANS

- A. I/O POINTS LIST
 - 1. Fan start/stop – DO
 - 2. Fan status – DI

4.8 OUTDOOR AIR CONDITIONS

- A. I/O POINTS LIST
 - 1. Outdoor air temperature – AI
 - 2. Outdoor air humidity – AI
- B. The sensors shall be mounted in an area on the North side of the building where the representative temperature and humidity can be monitored, both shall have sun shields. Based on the outside air temperature and humidity the B.A.S. shall calculate the outdoor enthalpy, wet bulb, and dew point temperatures. The outdoor air temperature and humidity shall be broadcast as global information for use by the other control programs.

4.9 IDF AND MDF ROOMS

A. I/O POINTS LIST

1. Space temperature – AI

B. The EMCS shall monitor the space temperature in the IDF and MDF rooms.

C. The EMCS shall report a high temperature alarm to the computers, pagers, and/or text message compatible cell phones designated by the School district personnel if the space temperature rises above 68°F (adjustable) for five (5) minutes (adjustable).

4.10 UNIT HEATER

A. I/O POINTS LIST

1. Space temperature - AI
2. UH start/stop and hot water valve open/close - DO

B. A space temperature sensor shall monitor the air temperature in the space. If the space temperature falls below 60 degrees F (operator adjustable) the Unit Heater fan shall be energized and the hot water valve shall be opened. The fan shall continue to run with the hot water valve open until the space temperature rises by 4 degrees F (operator adjustable).

4.11 DX/ GAS RTU WITH HOT GAS REHEAT AND CO₂

A. I/O POINTS LIST

1. Space temperature – AI
2. Discharge air temperature – AI
3. Return air temperature - AI
4. RTU fan status – current switch - DI
5. DX Cooling – Multiple stages as necessary- DO
6. Heating – multiple stages as necessary - DO
7. RTU fan start/stop - DO
8. Exhaust fan start/stop - DO
9. Outdoor air damper – AO
10. Return Air CO₂ – AI

END OF SECTION 23 09 23

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DUCTWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Low pressure duct.
- B. Duct pressure testing.

1.2 RELATED WORK

- A. Section 09900 - Painting: Weld priming, weather resistant, paint or coating.
- B. Section 15140 - Supports and Anchors: Sleeves.
- C. Section 15250 - Mechanical Insulation.
- D. Section 15910 - Duct Accessories.
- E. Section 15990 - Testing, Adjusting and Balancing.
- F. Section 013300 Submittals.
- G. Section 01524 Construction Waste Management
- H. Section 01352 LEED Requirements
- I. Section 01611 Environmental Management
- J. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- A. ASHRAE - Handbook 1993 Fundamentals; Chapter 32 - Duct Design.
- B. ASHRAE - Handbook 1992 HVAC Systems and Equipment; Chapter 16 - Duct Construction.
- C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- D. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- E. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
- F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- G. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- H. SMACNA - Low Pressure Duct Construction Standards.

- I. UL 181 - Factory-Made Air Ducts and Connectors.
- J. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- K. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.

1.4 DEFINITIONS

- A. Duct sizes shown are net inside clear dimensions. Duct shall be externally insulated. Where offsets or transitions are required, the duct shall maintain the equivalent diameter based on hydraulic diameter and rectangular duct size for equal flow, velocity and pressure drop as calculated by Huebscher formulae #30 and/or 31 in ASHRAE Duct Design Fundamentals Handbook and Figure 5 Friction Chart for round duct.
- B. Low Pressure: Three pressure classifications: 1/2 inch WG positive or negative static pressure and velocities less than 2,000 fpm; 1 inch WG positive or negative static pressure and velocities less than 2,500 fpm, and 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm. All ducts shall be sealed as specified, independent of SMACNA pressure class.

1.5 SUBMITTALS

- A. Refer to other applicable sections for additional coordination drawings, duct shop drawings and product data and conform to provisions of Division 1.
- B. Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work.
- C. The Contract Documents are schematic in nature and are to be used only for design intent. The Contractor shall prepare coordination and sheet metal shop drawings, fully detailed and drawn to scale, indicating all architectural partitions, structural conditions, all plumbing pipe and light fixtures co-ordinations, and all offsets and transitions as required to permit the duct to fit in the space allocated and built and show all bottom of duct elevations. All duct revisions required as a result of the Contractor not preparing fully detailed shop drawings will be performed at no additional cost to the Owner.
- D. Sheet metal ductwork "shop" drawings shall be made after actual job measurements are obtained. Sheet metal ductwork drawings shall indicate the coordination of the Contractor with sprinkler piping and other mechanical and electrical services installed under Division 15 and 16. These "Shop Drawings" shall be submitted for review as specified. Ductwork joint, connection, ductwork "shop" drawing submittal. Details shall be indexed and index number shall appear on ductwork "shop drawing" at its point of use.
- E. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:

- a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
- b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
- c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 1.
- B. Store and protect products under provisions of Division 1.
- C. Protect duct from contamination by dirt, dust or rain by covering openings; do not store duct in open on site.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.

- a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 ACCEPTABLE MANUFACTURERS

- A. Armco - "Zinc-Grip".
- B. Flex-master.
- C. Substitutions: Under provisions of Division 1.

2.5 DUCTWORK GENERAL

- A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA Duct Manuals where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein. All exhaust ductwork including toilet room exhausts shall be constructed and leak tested as specified for medium pressure supply ducts at negative pressure.
- B. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Architect.
- C. All duct sizes shown on the Drawings are air stream sizes. Allowance shall be made for internal lining where required, to provide the required cross sectional area.
- D. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.
- E. Except for special ducts specified elsewhere herein, all sheet metal used on the project shall be constructed from prime galvanized steel sheets and/or coils up to 60" in width. Each sheet shall be stenciled with manufacturer's name and gauge. Coils of sheet steel shall be stenciled throughout on ten foot (10') centers with manufacturer's name and must be visible after duct is installed. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."
- F. Where ducts, exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.

2.6 MATERIALS

- A. General: Non-combustible and conforming to requirements for Class 1 air duct materials, or UL 181.

- B. Steel Ducts: ASTM A525 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq. ft. for each side in conformance with ASTM A90. Minimum gauge for all duct shall be 26 gauge (0.019").
- C. Flexible Round Ducts:
 - 1. Low pressure: Interlocking spiral wire of galvanized steel or aluminum construction with flexible trilaminate inner fabric rated to 6 inches WG positive and 1 inches WG negative for low pressure ducts, insulated with 1" thick fiberglass insulation and reinforced metalized outer vapor barrier; Flexmaster type 5-m insulated or equal, NFPA 90A and U.L. 181 class 1 listed;
- D. Fasteners: Rivets, bolts, or sheet metal screws.
- E. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
- F. Hanger Rod: Steel, galvanized; continuously threaded.

2.7 LOW PRESSURE DUCT

- A. The scope of low pressure ductwork is defined as all ductwork downstream of terminal units, and all exhaust ductwork downstream of fans. Construction of all low pressure duct shall be in accordance with Low Velocity Duct Construction Standards as published by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and shall be sealed and tested at 3" static with the same test procedures as required by SMACNA.
- B. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.
- C. The metal gauges listed in the latest SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct are the minimum which shall be used for this project. It shall be noted that the Contractor is responsible that the metal gauge selected is heavy enough to withstand the physical abuse of the installation.
- D. Elbows shall be radius type and have a centerline radius of 1-1/2 times the duct diameter or width. Elbows in round ducts may be smooth radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.
- E. SEALANT: All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Polymer Adhesive "Airseal #11", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Weather" (United McGill Corp.) neoprene based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.
- F. Fabricate and support in accordance with SMACNA Low Pressure Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated, except that all duct joints and longitudinal seams for

all SMACNA classes of duct shall be sealed with U.L. Listed Hardcast DT-tape and sealant FTA-20.

- G. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by approved shop drawings.
- H. Construct tees, offsets, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide single thickness turning vanes for duct velocities up to 1500 fpm and for higher duct velocities, provide airfoil turning vanes.
- I. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- J. Use crimp joints with bead for joining round duct sizes 6 inch smaller with crimp in direction of air flow.
- K. Use double nuts and lock washers on threaded rod supports.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Obtain manufacturer's inspection and acceptance of fabrication and installation of duct at beginning of installation.
- B. Provide openings in duct where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal well and closure device to ensure against air leakage. Where openings are provided in insulated duct, install insulation material inside a metal ring.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Connect fan coil units to low pressure OA intake ducts with short length of flexible duct. Hold in place with corrosion resistant clamp or strap.
- E. Connect air distribution devices to low pressure ducts with 6 feet maximum, 4 feet minimum, length of flexible duct. Hold in place with corrosion resistant strap or clamp.
- F. During construction provide temporary closures of metal or taped polyethylene on open duct to prevent construction dust from entering duct system.
- G. The interior surface of all duct shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.
- H. Where ducts pass through floors, provide structural angles for duct support. Where ducts pass through walls in exposed areas, install suitable sheet metal escutcheons.
- I. All angles shall be carried around all four sides of the duct or group of ducts. Angles shall overlap corners and be welded or riveted.

- J. All ducts shall be fabricated in a manner to prevent the seams or joints being cut for the installation of air distribution devices.
- K. All rectangular duct located exposed on roof shall have top horizontal surface "crowned or sloped" to prevent water from ponding. Ref: Insulation for additional requirements.
- L. Provide all new round flex duct maximum length 2'-0", for extension use round sheet metal duct externally insulated with 1-1/2" thick, 1.5 p.c.f. Density fiberglass insulation with "F-S-K-L" (foil-skrim-kraft-laminate) vapor barrier.
- M. Provide round spin-in fittings with locking quadrant butterfly volume dampers for all round duct connections to rectangular ducts. Spin-in and flex duct shall be same size as air distribution device neck diameter. Secure flex duct to spin-in and air distribution device neck with stainless steel worm gear clamps and seal vapor barrier. Suspend flex duct from structure above; round and flexible duct shall be as detailed by SMACNA in section iii round, oval and flexible duct. Round duct seams shall be type RL-1 spiral seam or seam type RL-5 grooved seam flat pipe lock constructed in accordance with SMACNA figure 3-1; flexible duct supports shall be constructed and installed in accordance with SMACNA figures 3-9 and 3-10.
- N. Duct dimensions shown are net clear Internal Dimensions; allowance must be made for 1-1/2" thick external insulation as specified; all rectangular and round supply air, return air, outside air and exhaust air duct shall be galvanized sheet metal.
- O. Provide duct test wells at all locations required for testing, adjusting balancing, and temperature measuring.
- P. All duct shall be mounted tight to underside of structure and shall be top level with bottom and side transitions only, except that allowance shall be made for duct to be externally insulated, which shall be mounted 3" below structural beams and joists or other obstruction to allow installation of the external duct insulation. Some ducts may require the use of "ESS"-drive joints or flat seams to allow crossing of duct or installation of other equipment or piping. Raise existing duct where required to allow installation of other duct or equipment; use 45 degree radius elbows (center line radius = 1.5 times duct height) to offset.
- Q. Typical supply, return and exhaust duct shall be as detailed by SMACNA in Section II fittings and other construction. All 90 degree elbows shall be constructed in accordance with SMACNA figure 2-2, style RE-1 radius elbow (center line radius = 1.5 times duct height or width), space permitting or style RE-2 square throat with turning vanes (provide duct access panel up stream of turning vanes for cleaning purposes).
- R. Turning vanes shall be installed in accordance with figure 2.3; single wall type with trailing edge for duct velocities up to 1500 fpm and double wall turning vanes above 1500 fpm duct velocity.
- S. Parallel flow branches shall be constructed in accordance with figure 2-7. Rectangular duct branch connections shall be expanded 45 degree entry type and round branch duct connections shall be spin-in type in accordance with figure 2-8 and offsets and transitions shall be in accordance with figure 2-9.
- T. Duct access doors shall be constructed in accordance with figure 2-12 and shall have a frame type 3, position 3 hinge with a type 2 locking handle; single and multi-blade volume dampers shall be in accordance with figures 2-14 and 2-15 respectively and shall have operator extensions when provided on externally insulated ducts; air distribution device connections shall be in accordance with figure 2-16 and ceiling diffuser branch ducts shall be in accordance with figure 2-17.

- U. Rectangular duct connections at all air moving equipment shall be flexible neoprene fabric and installed in accordance with figure 2-19.
- V. Seal all non-welded duct joints of all SMACNA pressure classes with Hard-cast DT-cotton tape and duct sealer FTA-20 for indoor duct and duct sealer FTA-50 for exterior duct.

3.2 DUCT APPLICATION SCHEDULE

A.	AIR SYSTEM	MATERIAL
B.	Low Pressure Supply or return	Galvanized Steel
C.	Return and Relief	Galvanized Steel
D.	General Exhaust	Galvanized Steel
E.	Outside Air Intake	Galvanized Steel
F.	Kitchen Exhaust	16 Gauge Stainless Steel (welded)
G.	Fume Hood Exhaust	16 Gauge Stainless Steel (welded)
H.	Science Wet Lab Supply and Return	16 Gauge Stainless Steel (welded)
I.	Shower Area Supply and Return	16 Gauge Stainless Steel (welded)

3.3 DUCT HANGERS AND SUPPORTS

- A. All ducts shall be properly suspended or supported from the building structure. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Strap hanger shall be attached to the bottom of the duct. The spacing, size and installation of hangers shall be in accordance with the recommendations of SMACNA, latest edition.
- B. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor with sheet metal screws or rivets. The floor supports may also be secured to ducts by rods, angles or flat bar to the duct joint or reinforcing. Miscellaneous steel supports for duct risers shall be provided under this Division.

3.4 ADJUSTING AND CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION 23 31 00

23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. HVAC air distribution ductwork.
- B. Duct pressure testing.

1.2 RELATED WORK

- A. Section 09900 - Painting: Weld priming, weather resistant, paint or coating.
- B. Section 15140 - Supports and Anchors: Sleeves.
- C. Section 15250 - Mechanical Insulation.
- D. Section 15910 - Duct Accessories.
- E. Section 15990 - Testing, Adjusting and Balancing.
- F. Section 013300 Submittals.
- G. Section 01524 Construction Waste Management
- H. Section 01352 LEED Requirements
- I. Section 01611 Environmental Management
- J. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- A. ASHRAE – Fundamentals Handbook, Latest Version; Duct Design.
- B. ASHRAE - HVAC Systems and Equipment Handbook, Latest Version; Duct Construction.
- C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- D. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- E. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
- F. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- G. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

H. SMACNA - Duct Construction Standards.

I. UL 181 - Factory-Made Air Ducts and Connectors.

J. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

K. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.

1.4 DEFINITIONS

A. WG - Water Gauge

B. Static Pressure - Total air pressure less velocity air pressure. Static pressure type is defines as positive or negative pressures relative to standard atmospheric conditions unless denoted otherwise.

C. Duct Size - Net inside clear dimensions after insulation. Where offsets or transitions are required, the duct shall maintain the equivalent area based on hydraulic diameter and rectangular duct size for equal flow, velocity and pressure drop as calculated by Huebscher Formula #30 and/or #31 in ASHRAE Duct Design Fundamentals Handbook and associated Friction Chart for round duct.

D. Pressure Classification - SMACNA standard classification system for ductwork applications not exceeding listed static pressure and velocity services. SMACNA standard static pressure classes are defined as follows:

Pressure Class	Operating Pressure (WG)	Pressure Type	Max Velocity (fpm)	Seal Class
1/2	< 1/2"	Any	< 2,000	C
1	>1/2" to 1"	Any	< 2,500	C
2	>1" to 2"	Any	< 2,500	B (note 1)
3	>2" to 3"	Any	<4,000	B
4	>3" to 4"	Positive Only	<4,000	A
6	>4" to 6"	Positive Only	As Indicated	A
10	>6" to 10"	Positive Only	As Indicated	A

Notes 1: Seal Class B required exceeding SMACNA minimum requirement.

1.5 SUBMITTALS

A. Refer to other applicable sections for additional coordination drawings, duct shop drawings and product data and conform to provisions of Division 1.

B. Shop Drawings:

1. Prepare and submit ductwork shop drawings prior to fabrication and installation of ductwork. Contract documents are schematic in nature and are not an acceptable substitute for ductwork shop drawings.
2. Include floor plans drawn to scale not less than 1"=1/4" over appropriate project backgrounds. Include duct elevations and sections where proposed duct configurations cannot be fully depicted in plan view.
3. Include relevant details such as duct size dimensions, pressure classification, sheet metal gages, joining methodology, duct construction technology, fittings and duct accessories prior to start of work.
4. Include coordination with the work of other applicable trades including architectural partitions, piping, electrical, lighting, and ceiling systems.
5. Indicate bottom of duct elevation dimensions.
6. Include details for offsets and transitions as required to permit ductwork to fit in the installation space allocated. Verify actual project field conditions and measurements as required.
7. Owner assumes no responsibility for reimbursing additional costs for duct revisions and/or rework required as a result of failure to prepare fully developed and detailed shop drawings.

C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and protect products under provisions of Division 1.

B. Protect duct from exposure to weather. Do not store duct in uncovered areas.

- C. Protect duct from contamination by covering openings until the time of installation. Maintain coverings over installed duct openings throughout construction progress until duct system is fully closed and complete.
- D. Prevent entry into and/or habitation of ductwork by animals during storage and construction.
- E. Restore ductwork to like-new condition or replace contaminated by lack of adequate protection at no additional cost to owner.

1.7 QUALITY CONTROL

- A. Obtain manufacturer's inspection and acceptance of installation of duct at beginning of installation for factory prefabricated duct systems.
- B. Provide 100% visual inspection of duct joint sealing prior to installation of thermal insulation coverings.
- C. PRESSURE TESTING
 - 1. Pressure test ducts rated for Pressure Class 3 inch or higher.
 - 2. Conduct tests using procedures consistent with SMACNA HVAC Duct Leakage Test Manual.
 - 3. Determine maximum acceptable rate of air leakage using duct leakage formula as follows:

$$F = C_L \times P^{0.65}$$

Where: F = Maximum permissible airflow leakage in cfm/100 sq. ft. duct surface
P = Ducts static pressure in inch WG
C_L = Leakage Class according to the table below

Duct Construction	Seal Class A	Seal Class B
Rectangular Construction	C _L = 6	C _L = 12
Round or Oval Construction	C _L = 3	C _L = 6

- 4. Conduct duct leakage tests witnessed in writing by owner's designated representative, independent TAB service, project commissioning authority, independent construction inspector, engineer of record, and/or authority having jurisdiction where required. Schedule testing with advance notification for test witness(s).
- 5. Correct and retest ducts failing leakage tests at no additional cost to owner.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.

- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 ACCEPTABLE MANUFACTURERS

- A. Flexible Duct Runouts
 - 1. Flex-master.
 - 2. Thermaflex
 - 3. JP Lamborn Co.

2.5 MATERIALS

- A. General: Non-combustible and conforming to requirements for Class 1 air duct materials, or UL 181.
- B. Non-Welded Steel Ducts: ASTM A525 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq. ft. for each side in conformance with ASTM A90.
- C. Welded Carbon Steel Ducts: ASTM 568 rolled carbon steel; SMAW, FCAW, or GMAW welded; minimum 18 gauge sheet metal thickness.
- D. Welded Stainless Steel Ducts: ASTM A167, Type 304; GMAW welded; minimum 16 gauge sheet metal thickness.
- E. Fasteners: Rivets, bolts, or sheet metal screws matching base duct materials.
- F. Sealant: Non-hardening, water resistant, fire resistive, suitable for applications and compatible with mating materials
 - 1. High solids mastics - high density type with excellent adhesions and elasticity suitable for sealing fillets, groves, and flanges.
 - 2. Liquid sealants - formulated specifically for duct applications containing not more than 60% volatiles suitable for filling voids 1/16 inch or less. Provide taped joint reinforcement for liquid sealants except machine fabricated longitudinal seams and slip-type joints.
 - 3. Reinforcing tapes - suitable for use with liquid sealed joints only. Pressure sensitive adhesive tape sealing systems are not acceptable without liquid mastic overcoat.

4. Gaskets: soft elastomeric butyl rubber with adhesive backing suitable for use with flanged joints.
5. Liquid sealants containing not more than 50% volatiles. May be used for slip type joint assembly to fill voids up to 1/16 inch clearance.

G. Hangers

1. Strap: Steel, galvanized
2. Rod: Steel, galvanized; continuously threaded.

2.6 CONSTRUCTION

A. GALVANIZED STEEL RECTANGULAR DUCT

1. Single or double wall construction as indicated by application.
2. Minimum 26 gauge sheet metal thickness
3. Longitudinal seams complying with the following industry standards:
 - a. Inside Groove Seam
 - b. Sliding Seam
 - c. Pittsburgh Lock
 - d. Button-Punch Snap Lock
4. Transverse joints complying with the following industry standards:
 - a. Drive Slip
 - b. S Slip
 - c. Reinforced Bar-S Slip
 - d. Pocket Joint
 - e. Flanged Systems (Ductmate, MEZ, or equal) comprised of:
 - 1) Rolled flanges with integral mastic seals
 - 2) Bolted preformed corner pieces
 - 3) Sealing gaskets
 - 4) Flange joint drive cleats
5. Sealing Requirements
 - a. Class A – All transverse joints, longitudinal seams, and duct wall penetrations
 - b. Class B – All transverse joints and longitudinal seams
 - c. Class C – All transverse joints
6. except that all duct joints and longitudinal seams for all SMACNA classes of duct shall be sealed with U.L. Listed Hardcast DT-tape and sealant FTA-20.

B. GALVANIZED STEEL ROUND OR OVAL DUCT

1. Single or double wall construction as indicated by application.
2. Minimum 26 gauge sheet metal thickness
3. Longitudinal seams complying with the following industry standards:
 - a. Continuous interlocking spiral wound
 - b. Continuously seam welded
 - c. Butt seam welded
 - d. Gore locked seam
4. Transverse joints complying with the following industry standards:
 - a. Pipe & fitting coupled slip joint with radial fasteners
 - b. Swedge sleeve
 - c. Welded flanged & gasketed

C. WELDED LOW CARBON STEEL DUCT

1. Minimum 16 gauge thickness for grease laden exhaust service
2. Minimum 18 gauge thickness for services other than grease laden exhaust
3. Fully welded construction complying with one of the following industry standards
 - a. Shielded metal arc welding (SMAW)
 - b. Flux core arc welding (FCAW)

- c. Gas metal arc welding (GMAW)
- 4. Fully welded longitudinal joints and transverse seams for grease laden kitchen exhaust applications.
- 5. Welded longitudinal seams with gasketed flanged transverse joints for applications other than grease laden kitchen exhaust.

D. WELDED STAINLESS STEEL DUCT

- 1. Minimum 16 gauge thickness for laboratory exhaust service
- 2. Minimum 18 gauge thickness for services other than laboratory exhaust
- 3. Welded construction complying with industry standard gas metal arc welding (GMAW)
- 4. Fully welded longitudinal joints and transverse seams with gasketed flanged connections at equipment connections only for laboratory exhaust applications.
- 5. Welded longitudinal seams with gasketed flanged transverse joints for applications other than laboratory exhaust.

E. FLEXIBLE ROUND DUCT

- 1. Flexmaster type 5M insulated or equal.
- 2. Compliant with NFPA 90A & 90B
- 3. U.L. 181 Class 1 listed
- 4. ASTM E96 Procedure A rated for 0.05 Perm
- 5. Interlocking spiral wire of galvanized steel or aluminum construction
- 6. Aluminum foil, fiberglass, & aluminized polyester trilaminate liner
- 7. Rated to 6 inches WG positive and 1 inches WG negative
- 8. Insulated with 1" thick fiberglass insulation meeting R4.2
- 9. Reinforced metalized outer vapor barrier

F. DOUBLE WALL THERMAL DUCT FOR INTERIOR APPLICATIONS

- 1. Shop fabricated or factory prefabricated double wall duct systems consisting of continuous inner and outer wall metal duct sections with integral thermal insulation preinstalled in the annular space separating the inner and outer wall sections.
- 2. Reference Section 230713 HVAC Insulation, or other applicable Division 23 Sections for specific insulation requirements by application.
- 3. Paintable outer surface suitable for use in aesthetically exposed applications.
- 4. Comply with requirements of Galvanized Steel Rectangular, Round, and Oval Duct as applicable.
- 5. Provide double wall systems complete with all fittings, taps, and accessories.

G. DOUBLE WALL THERMAL DUCT FOR EXTERIOR EXPOSED APPLICATIONS

- 1. Shop fabricated or factory prefabricated double wall duct systems consisting of continuous inner and outer wall metal duct sections with integral thermal insulation preinstalled within the annular space separating the inner and outer wall sections.
- 2. Galvanized steel inner wall with welded stainless steel outer wall fabricated in flanged sections.
- 3. Reference Section 230713 HVAC Insulation, or other applicable Division 23 Sections for specific insulation requirements by application.
- 4. Inner duct wall complying with requirements of Galvanized Steel Rectangular, Round, and Oval Duct as applicable. Outer duct wall complying with requirements of Welded Stainless Steel Duct.
- 5. Provide double wall systems complete with all fittings, taps, and accessories.

H. DOUBLE WALL ACOUSTICAL DUCT

- 1. Shop fabricated or factory prefabricated double wall duct systems consisting of perforated inner and continuous outer wall metal duct sections with integral thermal acoustic insulation preinstalled in the annular space separating the inner and outer wall sections.

2. Provide inner duct with 3/32 inch diameter perforation holes staggered at 3/16 inch on center.
3. Reference Section 230713 HVAC Insulation, or other applicable Division 23 Sections for specific insulation requirements by application.
4. Paintable outer surface suitable for use in aesthetically exposed applications.
5. Conform to the requirements of galvanized steel rectangular, round, and oval duct as applicable.
6. Provide double wall systems complete with all fittings, taps, and accessories.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Fabricate and support in accordance with SMACNA Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for pressures indicated.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No reduction of equivalent duct area is permitted except by reviewed shop drawings.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Construct duct fittings per SMACNA standard details.
 1. Provide typical supply, return and exhaust duct as detailed by SMACNA Section II fittings and other construction.
 2. The interior surface of all duct shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.
 3. Provide 90 degree elbows constructed in accordance with SMACNA Figure 2-2, style RE-1 radius elbow (center line radius = 1.5 times duct height or width), space permitting; or style RE-2 square throat with turning vanes (provide duct access panel up stream of turning vanes for cleaning purposes) where required.
 4. Where rectangular elbows are used, provide single thickness turning vanes in accordance with SMACNA Figure 2.3; single wall type with trailing edge for duct velocities up to 1500 fpm and double wall turning vanes above 1500 fpm duct velocity.
 5. Provide parallel flow branches constructed in accordance with SMACNA Figure 2-7.
 6. Provide expanded 45 degree entry type rectangular duct branch connections.
 7. Provide spin-in type round branch duct connections in accordance with SMACNA Figure 2-8.
 8. Provide offsets and transitions in accordance with SMACNA Figure 2-9.
 9. Provide round spin-in fittings with locking quadrant volume dampers for all round duct connections to rectangular ducts. Spin-in and flex duct shall be same size as air distribution device neck diameter. Secure flex duct to spin-in and air distribution device neck with stainless steel worm gear clamps and seal vapor barrier. Suspend flex duct from structure above; round and flexible duct installations shall be as detailed by SMACNA in section III round, oval and flexible duct. Flexible duct supports shall be constructed and installed in accordance with SMACNA figures 3-9 and 3-10.
 10. Duct access doors shall be constructed in accordance with figure 2-12 and shall have a frame type 3, position 3 hinge with a type 2 locking handle; single and multi-blade volume dampers shall be in accordance with figures 2-14 and 2-15 respectively and shall have operator extensions when provided on externally insulated ducts; air distribution device connections shall be in accordance with figure 2-16 and ceiling diffuser branch ducts shall be in accordance with figure 2-17.

11. Rectangular duct connections at all air moving equipment shall be flexible neoprene fabric and installed in accordance with figure 2-19.
 12. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
 13. All duct shall be fabricated in a manner to prevent the seams or joints being cut for the installation of air distribution devices.
 14. Provide crimps in direction of air flow where crimp joints with bead are used for joining round duct sizes 6 inch smaller.
- E. Where required, provide ducts with "ESS"-drive joints or flat seams to allow crossing of duct or installation of other equipment or piping requiring tight clearances. Raise ducts where required to allow installation of other duct or equipment using 45 degree radius elbows (center line radius = 1.5 times duct height) to offset.
- F. Provide openings in duct where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal well and closure device to ensure against air leakage. Where openings are provided in insulated duct, install insulation material inside a metal ring.
- G. Connect fan coil units to low pressure OA intake ducts with short length of flexible duct. Hold in place with corrosion resistant clamp or strap.
- H. Connect air distribution devices to low pressure ducts with 6 feet maximum, 4 feet minimum, length of flexible duct. Hold in place with corrosion resistant strap or clamp.
- I. All rectangular duct located exposed on roof shall have top horizontal surface "crowned or sloped" to prevent water from ponding.

3.2 DUCT APPLICATION SCHEDULE

- A. Unless indicated otherwise, provide duct systems complying with the following application schedule:

<u>AIR SYSTEM</u>	<u>CONSTRUCTION</u>	<u>MATERIAL</u>	<u>Pressure Class</u>
Main Supply Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per AHU ESP, 3" Class Minimum
Main Supply Exposed in Unoccupied Spaces	Single Wall	Galvanized Steel	Per AHU ESP, 3" Class Minimum
Main Supply Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per AHU ESP, 3" Class Minimum
Main Supply Exposed Exterior	Single Wall	Welded Carbon Steel	Per AHU ESP, 3" Class Minimum
Downstream Supply Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per Terminal ESP
Downstream Supply Exposed	Double Wall	Galvanized Steel	Per Terminal

in Occupied Spaces			ESP
Draw-thru Transfer, Return, or Relief	Single Wall	Galvanized Steel	1" Class
Pressurized Transfer, Return, or Relief	Single Wall	Galvanized Steel	Per Fan ESP
Draw-thru O/A Intake Above Ceiling or Concealed	Single Wall	Galvanized Steel	1" Class
Draw-thru O/A Intake Exposed in Occupied Spaces	Double Wall	Galvanized Steel	1" Class
Pressurized O/A Intake Above Ceiling or Concealed	Single Wall	Galvanized Steel	Per Fan ESP, 2" Class Minimum
Pressurized O/A Intake Exposed in Occupied Spaces	Double Wall	Galvanized Steel	Per Fan ESP, 2" Class Minimum
General Exhaust	Single Wall	Galvanized Steel	Per Fan ESP, 1" Class Minimum
Grease Laden Kitchen Exhaust	Single Wall	Welded Carbon Steel	Per Fan ESP, comply with local code
Kitchen Dishwasher Exhaust	Single Wall	Welded Stainless Steel	Per Fan ESP, 18 Gauge Minimum
Laboratory Exhaust (General & Fume Hood)	Single Wall	Welded Stainless Steel	Per Fan ESP. 16 Gauge Minimum

3.3 DUCT HANGERS AND SUPPORTS

- A. All duct shall be properly suspended or supported from the building structure.
- B. The spacing, size and installation of hangers shall be in accordance with the recommendations of SMACNA, latest edition.
- C. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Hangers shall be attached to the bottom of the duct.
- D. Provide double nuts and lock washers on threaded rod supports
- E. All duct shall be mounted tight to underside of structure and shall be top level with bottom and side transitions only, except that allowance shall be made for duct to be externally insulated, which shall be mounted 3" below structural beams and joists or other obstruction to allow installation of the external duct insulation.
- F. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor. Secure floor supports to duct using rods, angles or flat bar to the duct joint or

reinforcing. Provide miscellaneous steel supports for duct risers as required at no additional cost to owner.

- G. Where ducts pass through walls in exposed areas, provide framed openings constructed of welded metal angles. All angles shall be carried around all four sides of the duct or group of ducts.

3.4 ADJUSTING AND CLEANING

- A. Clean duct system by vacuuming and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.5 TESTING

- A. Pressure test ductwork per Quality Control requirements.

END OF SECTION 23 31 13

23 33 00

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Backdraft and pressure relief dampers.
 2. Barometric relief dampers.
 3. Manual volume dampers.
 4. Control dampers.
 5. Fire dampers.
 6. Duct-mounted access doors.
 7. Flexible connectors.
 8. Flexible ducts.
 9. Duct accessory hardware.
- B. RELATED SECTIONS:
1. Section 013300 Submittals.
 2. Section 01524 Construction Waste Management
 3. Section 01352 LEED Requirements
 4. Section 01611 Environmental Management
 5. Section 01570 Pollution Prevention and Control

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- F. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.

- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.1 MATERIALS

- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90 (Z275).
 - 2. Exposed-Surface Finish: Mill phosphatized.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed and exposed ducts.
- E. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- F. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Greenheck Fan Corporation.
 3. Nailor Industries Inc.
 4. Pottorff; a division of PCI Industries, Inc.
 5. Ruskin Company.
 6. American Warming and Ventilating.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.063-inch- thick extruded aluminum with welded corners and mounting flange.
- F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum noncombustible with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
 1. Material: Stainless steel.
 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Synthetic pivot bushings.
- M. Accessories:
 1. Adjustment device to permit setting for varying differential static pressure.
 2. Counterweights and spring-assist kits for vertical airflow installations.
 3. Electric actuators.
 4. Chain pulls.
 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 6. Screen Material: Aluminum.
 7. Screen Type: Bird.
 8. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. American Warming and Ventilating; a division of Mestek, Inc.
 3. Greenheck Fan Corporation.
 4. Lloyd Industries, Inc.
 5. Nailor Industries Inc.
 6. Pottorff; a division of PCI Industries, Inc.
 7. Ruskin Company.

- 8. American Warming and Ventilating.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.063-inch- (thick extruded aluminum], with welded corners and mounting flange.
- F. Blades:
 - 1. Multiple, 0.025-inch-thick, roll-formed aluminum.
 - 2. Maximum Width: 6 inches (150 mm).
 - 3. Action: Parallel.
 - 4. Balance: Gravity.
 - 5. Eccentrically pivoted.
- G. Blade Seals: Neoprene.
- H. Blade Axles: Nonferrous metal.
- I. Tie Bars and Brackets:
 - 1. Material: Aluminum
 - 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:
 - 1. Flange on intake.
 - 2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Pottorff; a division of PCI Industries, Inc.
 - g. Ruskin Company.
 - h. Trox USA Inc.
 - i. American Warming and Ventilating.
 - 2. Standard leakage rating, with linkage outside air stream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat-shaped, galvanized channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.

- b. Parallel- or opposed-blade design.
- c. Stiffen damper blades for stability.
- d. Galvanized, 0.064 inch thick.
- 6. Blade Axles: Nonferrous metal.
- 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Tie Bars and Brackets: Galvanized steel.

2.5 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
 - 1. American Warming and Ventilating.
 - 2. Greenheck Fan Corporation.
 - 3. METALAIRE, Inc.
 - 4. Nailor Industries Inc.
 - 5. Pottorff; a division of PCI Industries, Inc.
 - 6. Prefco; Perfect Air Control, Inc.
 - 7. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside air stream fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- K. Furnish and install where shown on the drawings or required by the Specifications, fire dampers meeting the following requirements.
- L. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555. All dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural drawings) protection rating, 165 or 212 degree F fusible link, and shall bear a U.L. label in accordance with Underwriters Laboratories labeling

procedures. Fire dampers shall be constructed such that the damper frame material and the curtain material shall be galvanized.

- M. Fire dampers shall be curtain blade or multi-blade type and the damper shall be so constructed that the blades are either out of the air stream or installed in an oversized sleeve to provide a 100 percent free area of the duct in which the damper is housed.
- N. The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500 Standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05 inch water gauge.
- O. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations shown in the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles and other material and practices required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be a minimum of 1 1/2 inch by 1 1/2 inch by 14-gauge and bolted, tack welded or screwed to the sleeve at maximum spacings of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the gauge of the duct defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6" water gauge static pressure.
- P. The damper installation shall be in accordance with the damper manufacturer's instructions.
- Q. All fire dampers shall comply with the specification as written above and shall be Ruskin Model IBD2 (Style C, CR or CO), Greenheck Model FD-150 (Type C, CR or CO), or Pottorff.
- R. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.
- S. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design airflow at the point of installation. The minimum closure pressure rating shall be 8" wg for airflow in either direction.
- T. Combination Fire/Smoke Dampers
 1. Furnish and install where shown on the Drawings, or as required by the Specifications, combination fire/smoke dampers meeting the following requirements.
 2. Each combination fire/smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gauge pressure and 8 cfm per square foot at 4 inches water gauge pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.)
 3. The damper frame shall be a minimum of 20-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be

either parallel or opposed blade type. The blades shall be constructed with a minimum of 14-gauge equivalent thickness. The blade edge seal material shall be able to withstand 450 degrees F. The jamb seals shall be flexible stainless steel compression type or lap seal type.

4. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 250 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and operators. The manufacturer shall provide a factory assembled sleeve. The sleeve shall be a minimum of either 20-gauge for dampers where neither width nor height exceeds 48 inches or 16-gauge where either dimension equals or exceeds 48 inches.
5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.
6. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat /releasing device. The firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The Firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.
7. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.
8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.
9. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 6" W.G. static pressure.
10. All combination fire/smoke dampers shall comply with the specification as written above and shall be Ruskin Model FSD-60, Greenheck Model FSD-33, or Pottorff.
11. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.
12. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 8" wg for air flow in either direction.

2.6 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Flexmaster U.S.A., Inc.
 3. Greenheck Fan Corporation.
 4. McGill AirFlow LLC.
 5. Nailor Industries Inc.
 6. Pottorff; a division of PCI Industries, Inc.
 7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 4. Factory set at 10-inch wg.
 5. Doors close when pressures are within set-point range.
 6. Hinge: Continuous piano.
 7. Latches: Cam.
 8. Seal: Neoprene or foam rubber.
 9. Insulation Fill: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.7 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; [polyethylene] [aluminized] vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

- C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 210 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- D. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches to suit duct size.
 - 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.8 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.9 LOW PRESSURE TAPS (CONICAL BELL MOUTH FITTINGS)

- A. Conical fittings may be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles), even though a volume damper is specified for the air device. (This does not apply to medium pressure duct.) Spin-in fittings shall be sealed at the duct tap with a gasket, or compression fit, or sealed with sealant specified for medium pressure ductwork. The location of spin-in fittings in the ducts shall be determined after dual or single duct terminal units are hung or the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends.
- B. The conical fitting shall be made of at least 26-gauge galvanized sheet metal. The construction to be a two-piece fitting with a minimum overall length of 6 inches and shall be factory sealed for high pressure requirements. Average loss coefficient for sizes 6, 8, and 10 shall be less than 0.055.
- C. Each to be provided with minimum 24-gauge damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.
- D. Provide flange and gasket with adhesive peel-back paper for ease of application. The fitting shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on-center with a minimum of four screws per fitting.
- E. The conical bellmouth fitting shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc., or Buckley Air Products, Inc., 'AIR-TITE'.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

3.2 DAMPERS

- A. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of the air flow, including all supply, return and exhaust branches, "division" in main supply, return and exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, the Contractor shall be responsible for the proper location of the access doors.
- B. Splitter dampers shall be fabricated of steel not lighter than 16-gauge. The leading edge of the damper shall be hemmed. Each splitter shall be a minimum of 12" long or 1-1/2 times the width of the smaller of the two branches it controls, whichever is greater. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, No. 644 on exposed externally insulated ductwork and No. 677 (2-5/8" diameter) chromium plated cover plate for concealed ductwork not above lay-in accessible ceilings. Furnish and install end bearings for the damper rods on the end opposite the quadrant when No. 555 or No. 644 regulators are used, and on both ends when No. 677 regulators are used.
- C. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.
- D. Dampers larger than three (3) square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and with end bearings supporting the axle.
- E. Volume dampers shall be equal to those of American Foundry. Blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16-gauge galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.
- F. Install all dampers furnished by the Temperature Control Manufacturer in strict accordance with the manufacturer's recommendations and requirements of these Specifications.
- G. All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equal, elevated dial operators. Insulation shall extend under the elevated dial. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635, or equal, dial operators. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.
- H. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- I. Set dampers to fully open position before testing, adjusting, and balancing.
- J. Install test holes at fan inlets and outlets and elsewhere as indicated.
- K. Install fire dampers according to UL listing.

- L. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream and downstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.

- M. Install access doors with swing against duct static pressure.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

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FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install roof and wall exhausters and cabinet and ceiling exhaust fans for mechanical systems.

1.2 RELATED SECTIONS

- A. Section 016600 – Product Storage and Handling Requirements.
- B. Section 016613 – Product Storage and Handling Requirements for Hazardous Materials.
- C. Section 016616 – Product Storage and Handling Requirements for Toxic Materials.
- D. Section 220526 – Hangers and Supports for Plumbing Piping and Equipment.
- E. Section 220543 – Vibration and Seismic Control for Plumbing and Piping Equipment.
- F. Section 233100 – HVAC Ducts and Casings.
- G. Section 233416 – Centrifugal HVAC Fans.
- H. Section 230593 – Testing, Adjusting, and Balancing for HVAC.
- I. Section 230513 – Common Motor Requirements for HVAC.
- J. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.
- K. Section 013300 Submittals.
- L. Section 01524 Construction Waste Management
- M. Section 01352 LEED Requirements
- N. Section 01611 Environmental Management
- O. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- A. AMCA 99 – Standards Handbook.
- B. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 – Test Code for Sound Rating Air Moving Devices.

- D. AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices.
- E. SMACNA – Low Pressure Duct Construction Standard.

1.4 SUBMITTALS

- A. Include fan curves with specified operating point clearly plotted.
- B. Include sound power levels for both fan inlet and outlet at rated capacity.
- C. Indicate special coating when required.
- D. Provide operation and maintenance manual.
- E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.
- F. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 - 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 - 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.

1.6 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. Greenheck.
- B. Cook.
- C. Penn Barry
- D. Acme

2.5 ROOF EXHAUSTERS

- A. Centrifugal or Axial Fan Unit: Backward inclined or airfoil design, v-belt or direct driven, with spun aluminum housing, resilient mounted motor and drive assembly, 1/2-inch mesh, 16 gauge

aluminum bird screen; square base to suit roof curb with continues curb gaskets; secured to roof curb with cadmium plated or stainless steel bolts and screws, as indicated in Drawings.

- B. Roof Curb: 14 inch with continuously welded seams, built-in cant strip, 1 inch insulation and curb bottom, hinged curb adapter sand factory installed door mailer strip. Where scheduled, provide interior baffle with acoustic insulation and increase curb height as required.
- C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.
- D. Back draft Damper: Gravity activated, aluminum multiple blade construction, felt edged with nylon bearings.
- E. Sheaves: Cast-iron or steel, dynamically balanced, bored to fit shafts and keyed; adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid position; and will not overload motor when adjusted to maximum pitch; fan shaft with self-aligning pre-lubricated ball bearings.
- F. Apply three coats of air dried Heresite coating both internal and external to all roof exhausters from corrosive areas.
- G. Motors: In total compliance with Section 230513.

2.6 UP-BLASTS EXHAUST FANS

- A. Centrifugal Fan Unit: Non-overloading backward inclined or airfoil design, v-belt driven, with spun aluminum housing, resilient mounted motor and drive assembly located out of airstream; square base to suit roof curb with continues curb gaskets; secured with cadmium plated or stainless steel bolts and screws.
- B. Motor enclosures: Totally enclosed fan cooled
 1. Motors are heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
 2. Mounted on vibration isolators, out of the airstream
 3. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
 4. Accessible for maintenance.
- C. Shafts and Bearings:
 - Fan shaft shall be ground and polished solid steel with an anti corrosive coating.
 - Permanently sealed bearings or pillow block ball bearings.
 - Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - Bearings are 100 percent factory tested
 - Fan Shaft first critical speed is at least 25 percent over maximum operating speed
- D. Roof Curb: 14 inch high aluminum construction with continuous seams, built-in cant strip and factory installed mailer strip. Roof curb shall match fan and shall be supplied by fan manufacturer. Provide sloped roof curb as required for installed equipment to set level.
- E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.
- F. Grease Collector: Provide grease trough and collectors for kitchen hood fans.

- G. Sheaves: Cast-iron or steel, dynamically balanced, bored to fit shafts and keyed; adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid position; and will not overload motor when adjusted to maximum pitch; fan shaft with self-aligning pre-lubricated ball bearings. Drive shall be designed for 165% of rated horsepower capabilities.
- H. Motors: In total compliance with Section 230513.

2.7 KITCHEN SUPPLY AIR FAN

- A. Kitchen Supply Fan shall be as manufactured by Greenheck or approved equal provided all specifications are met. Greenheck Model KSF equipment is used as the basis of design.
- B. Unit shall be of internal frame type construction of galvanized steel. All frames and panels shall be G90 galvanized steel. All metal-to-metal surfaces exposed to the weather shall be sealed, requiring no caulking at job site. Unit base to be designed for curb mounting. Unit base shall over hang the curb. Curb is recessed under the unit for a positive seal against water run-off. All components shall be easily accessible through removable doors. Permatector corrosion resistant exterior finish available for outdoor units.
- C. Weather hood shall be the same finish as the unit and shall be sized for low intake velocities, preventing entrainment of moisture.
- D. Filters shall be mounted in a straight or V-bank arrangement such that velocities across the filters do not exceed 550 feet per minute. Filters shall be 1 inch or 2 inch aluminum mesh and easily removable.
- E. Centrifugal fans shall be double width, double inlet. Fan and motor shall be mounted on a common base and shall be internally isolated. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently sealed ball bearing pillow blocks. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged speeds.
- F. Motors shall be energy efficient, complying with EPACT standards, for single speed ODP and TE enclosures. Motors shall be permanently lubricated, heavy duty type, matched to the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be fully machined cast, 10 horse power and less shall be supplied with an adjustable drive pulley.
- G. Control center shall include magnetic motor starter with thermal overload protection and manual reset, control circuit fusing, control transformer for 24 VAC circuit, integral door interlocking disconnect switch and distribution terminal strip. All internal electrical components shall be prewired for single point power connection. All electrical components shall be UL listed, approved or classified where applicable and wired in compliance with the National Electrical Code. Contactors and Class 20 adjustable overload protection shall be standard.

2.8 SOURCE QUALITY CONTROL

- A. The following tests must be conducted at the project site.
 - 1. Vibration test as described in Section 016600 – Product Storage and Handling Requirements, Section 016613 – Product Storage and Handling Requirements for Hazardous Materials, and Section 016616 – Product Storage and Handling Requirements for Toxic Materials.
- B. The following listed tests must be conducted at the manufacturer=s test facility.

1. Vibration test as described in Section 230593 – Testing, Adjusting, and Balancing for HVAC.
2. Sound test under AMCA Guidelines and Conditions. The sound power levels must not exceed those indicated on Drawings.

2.9 FUME HOOD MIXED-FLOW INDUCED DILUTION FANS (GREENHECK, COOK OR EQUAL)

- A. Impellers shall be mounted directly to the motor shaft to provide a direct drive arrangement 4 type fan. Motors shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.
- B. Mixed flow impellers shall consist of combination axial/backward curved blades and shall be of welded steel construction. The impellers shall have non-stall and non-overloading performance characteristics with stable operation at any point on the fan curves.
- C. Stationary discharge guide vane sections shall be provided to increase fan efficiencies.
- D. Fan dynamic balance not to exceed 0.5 mil., peak to peak, at the blade pass area when operating at fan frequency. Vibration isolation shall be limited to rubber-in-shear pad type isolators.
- E. Fan assemblies shall be designed for mounting on conventional roof curb without the need for guy wire supports.
- F. Discharges shall include twin FRP nozzles with passive third central stacks that are capable of generating aspiration. The FRP shall be chemically and UV resistant.
- G. Steel entrainment wind bands shall provide secondary induction of outside air. Induction shall take place downstream of the fan impeller and shall not influence BHP or static pressure requirements. Wind bands shall discharge up to 270% of the design flow rates. The manufacturer shall publish discharge volumes for all fans at specified primary exhaust flow.
- H. A non-ferrous inlet bell shall be provided in order to reduce sparking in the event of a motor bearing failure.
- I. Fans shall be modular construction and capable of being assembled on the roof.
- J. PTFE gaskets shall be provided at all companion flanged joints.
- K. Fasteners shall be 316 stainless steel.
- L. A bolted access door shall be provided for impeller inspection on each fan.
- M. Fans and accessories shall have internal drain systems to prevent rain water from entering building duct systems.
- N. Electric motors shall be TEFC Mill & Chemical duty with a 1.15 service factor and an L-50 bearing life of 200,000 hours. Motors shall have sealed bearings up through a 256T NEMA frame. Motors on BS-1 and larger fans shall be C-Face and foot mounted.
- O. A NEMA 3R non-fused disconnect switch shall be provided, mounted and wired to the motor.
- P. Coatings-All steel and aluminum surfaces shall prepared for coating by blasting or chemical etching. Coating will be:

1. Epoxy (4-5 mils) for protection against weather and dry chemical fumes.
2. Epoxy (8-10 mils) for protection against weather, chemical vapors and splashes.

2.10 ACCESSORIES

- A. Inlet mixing plenums shall be provided by the fan manufacturer. Each plenum shall be sized to support the weight and performance requirements of the number of fans listed on the schedule. Multiple fan plenums shall be double wall construction with structural stiffeners or shall be continuously welded, heavy gauge single wall construction. Single fan plenums shall be of continuously welded, heavy gauge steel construction. All plenums shall be capable of supporting the fan(s) without guy wires or supports. The plenums shall include hinged access doors and safety screens over primary air inlets. The primary air inlets shall be located on the bottom or side as noted on construction drawings. Coatings shall be the same as specified for the fans. Unless otherwise specified, plenums shall be suitable for mounting on roof curbs.
- B. Stainless safety screens shall be supplied over bottom primary air inlets.
- C. Bypass dampers shall be provided with all mixing plenums for outside make-up air with primary exhaust. Dampers will be:
 1. Louver/damper combinations, aluminum construction, manual locking quadrant.
 2. Opposed blade low leakage airfoil control dampers with extended shaft for connection to an operator. The dampers shall be aluminum construction. Rain hoods shall be provided with each damper. The dampers shall be controlled by a (hand quadrant/20 psi pneumatic/24V electric) operators. The operators shall be provided by controls manufacturer.
 3. Barometric controlled dampers, adjustable up to 3.0" pressure. Rain hood shall be provided with each damper.
- D. Low leakage isolation dampers shall be constructed of aluminum airfoil extrusions and coated with epoxy. Operators shall be 2 position, spring return and shall be 20 PSI pneumatic/24V/110V electric unless variable frequency drives are specified. The electric operator shall be factory wired (via a transformer when required) to the fan disconnect switch to open when the fan is energized and close via a spring return when de-energized. When the fan ships separate from the plenum, all wiring and conduit shall be factory supplied for easy connection in the field.
- E. Vortex breakers shall be provided on all side inlet and multiple fan plenums.
- F. Inlet spray nozzle(s) shall be mounted at fan inlet to provide wash down capability of fan while operating. Spray nozzles to be suitable for water or steam. Nozzles to be piped to the exterior of the fan with threaded end for field connection. All piping and nozzle components shall be stainless steel construction.
- G. A 14 gauge galvanized steel roof curb shall be provided to support the fans/plenums. The curb shall be minimum 14 gauge and canted for rigid in wind loads. The curb shall be _" high. The curb shall include a rigid fiberglass liner wood nailer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with 1/2" x 2" S.S. lag screws roof curb.

- C. Install flexible ductwork connections when fan connects to ductwork.
- D. Provide al ventilating and exhaust fans with integral vibration isolation.
- E. Water test ventilators after installation.

3.2 PAINTING

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Provide equipment with factory finish in accordance with the manufacturer's standards. Touch scratches and marks from handling and installation with masking enamel to match manufacturer's color.
- B. Where exhaust fans are required to have Heresite coating, have units factory finished with required number of coats prior to shipping to the job site.

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DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Round ceiling diffusers.
 2. Rectangular and square ceiling diffusers.
 3. Perforated diffusers.
 4. Louver face diffusers.
 5. Jet flow diffusers.
 6. Linear slot diffusers.
 7. Related Sections:
 8. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 9. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
- B. Related Sections:
1. Section 013300 Submittals.
 2. Section 01524 Construction Waste Management
 3. Section 01352 LEED Requirements
 4. Section 01611 Environmental Management
 5. Section 01570 Pollution Prevention and Control

1.3 SUBMITTALS

- A. First three paragraphs below are defined in Division 01 Section "Submittal Procedures" as "Action Submittals."
- B. Product Data: For each type of product indicated, include the following:
1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- C. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- D. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- E. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
 2. Method of attaching hangers to building structure.
 3. Size and location of initial access modules for acoustical tile.
 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 5. Duct access panels.
- F. Source quality-control reports.
- G. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 2. Local/Regional Materials:
 - a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
 4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
 6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

PART 2 - PRODUCTS - REFER TO DRAWINGS FOR SCHEDULE.

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

2.5 ACCEPTABLE MANUFACTURERS

- A. Titus
- B. Price
- C. Krueger
- D. Tuttle & Bailey

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

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FILTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Disposable media filters.
- B. Filter frames.
- C. Filter gauges.

1.2 RELATED SECTIONS

- A. Section 237300 – Indoor, Central-Station Air-Handling Units.
- B. Section 233100 – HVAC Ducts and Casings.
- C. Section 233600 – Air Terminal Units.
- D. Section 013300 Submittals.
- E. Section 01524 Construction Waste Management
- F. Section 01352 LEED Requirements
- G. Section 01611 Environmental Management
- H. Section 01570 Pollution Prevention and Control

1.3 REFERENCES

- A. UL 900 – Test Performance of Air Filter Units.
- B. ASHRAE 52 – Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter.

1.4 SUBMITTALS

- A. Include filter media, filter performance data, filter assembly and filter frames.
- B. Provide Operation and Maintenance manual.
- C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
 - 1. Recycled Content:
 - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
 - 2. Local/Regional Materials:

- a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
- b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
3. VOC data:
 - a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal's Standard GS-11.
 - b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
 - c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
 - a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.5 QUALITY ASSURANCE

- A. Provide filter media that is UL 900 listed, Class 2, as approved by local authorities.
- B. Provide all filters as product of one manufacturer.
- C. Assemble filter components to form filter banks from products of one manufacturer.

1.6 EXTRA MATERIALS

- A. Provide one spare set of disposable media filters at project final acceptance for each piece of equipment requiring filters.

1.7 MAINTENANCE

- A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation. During construction, if the air units operate at any time, minimum MERV 13 filters shall be installed and kept clean.
- B. Provide two sets of belts and three sets of filters for each unit. One set of filters to be installed when unit is started up and shall be protected from construction debris with additional media either at the first bank of filters, or covering each air intake (outside air and return air). Second set of filters to be installed when test and balance activities begin. At substantial completion shall inspect filters to determine if the third set should be installed or delivered to school operations personnel. Tag to identify associated unit.

PART 2 - PRODUCTS

2.1 ENVIRONMENTALLY PREFERABLE PRODUCTS

- A. Provide environmentally preferable products to the greatest extent possible.
 - 1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.
- B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.
- C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.2 RECYCLED CONTENT

- A. Provide recycled content products to the greatest extent possible.
 - 1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.3 REGIONAL MATERIALS

- A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
 - 1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles from the project site.
 - a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
 - 2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

2.4 MANUFACTURERS

- A. American Air Filter.
- B. Cam-Farr.
- C. Continental.

2.5 PANEL FILTERS

- A. All air filters shall be listed as (Class 1, Class 2) in accordance with Underwriters Laboratories, Inc., Building Materials Director requirements, except ultra-high efficiency filters, (HEPA or ULPA,) shall be manufactured of materials that are so listed by UL. All filters other than the ultrahigh efficiency type are to be rated in accordance with ASHRAE Test Standard 52-76 and performance characteristics are to be published in the manufacturer's literature. When specified performance characteristics are not published in the manufacturer's literature, the submittal data shall include certified documentation of performance by an approved independent test laboratory.

- B. Permanent, Washable: Viscous coated, high velocity filters. The net velocity through the filters shall not exceed 500 fpm. Filters shall be 2" (two inches) thick and the initial clean resistance to air flow shall not exceed 0.10" (one tenth inch) w.g. Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles. Furnish one complete set of spare filters for each system.
- C. Sectional, Renewable Media: Air filters shall be 2" (two inches) thick adhesive coated glass fiber media pads enclosed in sectional frames of not less than 16 (sixteen) gauge galvanized steel and equipped with a quick opening mechanism for changing filter media. The airflow capacity of the filters shall be based on a net filter face velocity not exceeding 350' (three hundred and fifty feet) per minute with an initial resistance no greater than 0.10" (one tenth inch) water gauge. When used as pre-filters, and mounted in the same holding frames as higher efficiency secondary air filters, the airflow capacity may be based on 500' per minute with an initial resistance not to exceed 0.17" water gauge. Filters shall have an average arrestance of not less than 70 to 75% when tested in accordance with ASHRAE Test Standard 52.
- D. Replaceable, Dry Type, Moderate Efficiency: Filters shall be of the pleated media, disposable type, 2" (two inches) deep in direction of airflow, Class 1 MERV 8. Each filter cell shall utilize a nonwoven, lofted cotton media with a net effective area of not less than 7.0 square feet of media per 1.0 square feet of filter face area, a media support grid, and enclosing high wet strength cell sides. The 96% free area welded wire support grid shall be continuously bonded to the leaving air face of the media to properly support the radially tapered, pleated media in the air stream through the life span of the filter. The media itself shall be cemented to the inside perimeter of the cell sides to prevent bypass of unfiltered air. Filter efficiency shall average not less than 25 to 30% when tested in accordance with ASHRAE Test Standard 52-76. Initial clean resistance to air flow shall not exceed 0.30" w.g. at 500 fpm filter face velocity. The 24" x 24" size shall be certified to have a dust holding capacity of not less than 265 grams of ASHRAE Test Dust when operated at 500 fpm to a final resistance of 1.0" w.g.
- E. Replaceable, Dry Type, Medium and/or High Efficiency (minimum MERV 13): Filters shall be 12" deep of the extended surface, supported pleat type. Each filter shall consist of high density, micro fine glass fiber media, media support grid, contour stabilizers, and enclosing galvanized steel frame. Media shall be laminated to a nonwoven synthetic backing to form a lofted surface for maximum dust holding capacity. The edges of the media shall be continuously bonded to the internal surfaces of the galvanized steel frame to prevent bypass of unfiltered air. Filter efficiency shall average not less than 80 to 85% when tested in accordance with ASHRAE Test Standard 52-76. Filters shall be 24" x 24" x 12" deep with an initial clean resistance not to exceed 0.35 inches w.g. at 500 fpm face velocity. The filters shall be certified to have a dust holding capacity of not less than 700 grams of ASHRAE Test Dust when operated at 500 fpm face velocity to a final resistance of 1" w.g.
- F. Fabricate filter frames and supporting structures of 16 gauge galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.
- G. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for required installation of filter media minimum 2 inch thick; for extended surface and high efficiency particulate filters, provide for upstream mounting.
- H. Side Servicing Housing: Flanged for connection of ductwork, of reinforced 16 gauge galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extended aluminum tracks or channels for primary or secondary filters with positive sealing gaskets.

2.6 FILTER GAUGES

- A. Each individual filter or filter bank handling 2,000 cfm or more shall be equipped with a diaphragm actuated dial and pointer type gauge with zero adjustment capability. The range of the scale shall be no greater than 1" w.g. above the filter manufacturer's recommended final resistance for the type of filter to which the gauge is being applied. Each gauge shall be provided with an adjustable signal flag, two static pressure taps with compression fittings, two three way vent valves with compression fittings, two lengths of aluminum tubing, and a mounting plate with screws.
- B. Provide dry contact switch to indicate high-pressure limit (adjustable) for connection by others to FCMS system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters temporary or permanent are in place. Replace temporary filter used during construction.
- D. Install static pressure taps upstream and downstream of filters. Mount on outside of filter housing of filter plenum, in accessible position. Adjust and level.
- E. Provide differential pressure sensor at filter bank of each air handling unit.

END OF SECTION 23 41 00

23 81 33

UNITARY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install and install direct expansion air condition system, including:
 - 1. Air handling/ fan coil unit.
 - 2. Outdoor condensing unit.
 - 3. Plenum/ pedestal.
 - 4. Thermostat.

1.2 RELATED SECTIONS

- A. Section 220700 – Plumbing Piping Insulation
- A. Section 230700 – HVAC Piping Insulation.
- B. Section 230993 –Direct-Digital Control System for HVAC.
- C. Section 230593 – Testing, Adjusting, and Balancing for HVAC.
- D. Coordinate with Commissioning Requirements indicated in Section 019113. This contractor is responsible to comply with all requirements for the above section.

1.3 REFERENCES

- B. ARI 240 – Air Source Unitary Heat Pump Equipment.
- A. ARI 270 – Sound Rating of Outdoor Unitary Equipment.

1.4 SUBMITTALS

- C. Include product data and schematic layouts showing condensing units, air handling/ fan coil unit, refrigerant piping and accessories required for complete system. Include complete pipe sizing data.
- A. Include rated capacities, dimensions, weights, accessories, required clearances, electrical requirements, wiring diagrams and location and size of field connections.
- B. Include manufacturer’s installation instructions.
- C. Provide operation and maintenance manual.

1.5 QUALITY ASSURANCE

1.6 WARRANTY

- A. Provide 1 year whole unit parts only warranty.

- B. Provide five-year manufacturer's replacement warranty on compressor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Carrier.
- B. Trane.
- C. Daikin

2.2 SYSTEM DESCRIPTION

- D. Provide split conditioning system consisting of indoor air handling/ fan coil unit, outdoor condensing unit, refrigerant piping, fittings and accessories, and controls. Factory assembled components and test unit.
- A. Heating and Cooling Capacities: As indicated on Drawings.
- B. Refrigerant shall be R-410A.

2.3 AIR HANDLING/FAN COIL UNIT

- E. Basic Unit:
 - 1. Fabricated exterior unit casing of heavy gauge galvanized steel, painted with epoxy based enamel paint. Provide color chart for color selection by Architect.
 - 2. All unit panels must be removable with a minimum 2 inch microbial resistant and glass fiber thermal insulation liner with sealed edges.
 - 3. Fabricate fan deck of galvanized steel. Fabricate drain pans of 304 stainless steel externally insulated with fire retardant, closed cell foam insulation.
 - 4. Provide liquid sensor at the shallowest part of the pan with all corresponding controls within the drain pan. Upon the presence of liquid, the sensor shall de-energize the unit and send an alarm signal to the BAS.
 - 5. Provide with integral double deflection supply grilles and hinged bar return grilles, unless otherwise indicated on the drawings to have ductwork connections with 1" duct collars, and one inch filter frame.
- B. Coils:
 - 1. Construct coils with 2" O.D. copper tubes with aluminum fins mechanically bonded to the tubes.
 - 1. Test al coils for design working pressure of 250 psig @ 200EF.
 - 2. Heating and cooling coils shall be sized as required to meet or exceed the capacities indicated on the drawings.
- C. Fans: Centrifugal, forward-curved, double-width wheels. Mount frame on vibration isolators.
- D. Motors: Resilient mounted, three-speed, permanent split capacitor type in total compliance with Section 230513 – Common Motor Requirements for HVAC.

- E. Filters: 1 inch disposable with galvanized holding frame in total compliance with Section 234100 – Particulate Air Filtration.

2.4 AIR COOLED CONDENSING UNITS

- F. Provide air cooled condensing units as scheduled; self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver and screens.
- A. Provide corrosion resistant materials for unit parts which come in contract with refrigerant.
- B. Provide timer conduits to prevent rapid cycling of compressor.
- C. Fabricate cabinet from galvanized steel, with baked enamel finish; provide removable access doors or panels with quick fasteners.
- D. Compressor: Hermetically sealed or semi-hermetic type, 1750 rpm, resiliently mounted with positive lubrication, crankcase heater, cylinder un-loaders for capacity modulation, motor overload protection, service valves, filter drier, suction and discharge valves, with gauge ports, and high and low pressure safety controls.
- E. Condenser:
 - 1. Seamless copper tubing with aluminum fins coil.
 - 2. Provide condenser fans which discharge, vertically and have direct fan resiliently mounted with guard and motor.
 - 3. Provide fan motor with permanently lubricated ball bearing type with built-in current and overload protection.
- F. Provide unit with high and low pressure cutouts for compressor, non-recycling pump down, reset relay and oil pressure safety (7 ½ ton units and larger). Provide with controls to permit operation down to 0 degree F ambient temperature at minimum compressor load.

2.5 PIPING

- G. Provide one refrigerant lint filter dryer and outside pressure taps in each refrigerant circuit.

2.6 CONTROLS

- H. Refer to Section 230993 –Direct-Digital Control System for HVAC.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Verify proper refrigerant charge and operating pressures. Supplement factory charge (R-410) if necessary.
- C. Mount unit in safe and accessible location for maintenance.

END OF SECTION 238133

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COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Coordinate with Commissioning Requirements indicated in Section 019113. This Contractor is responsible to comply with all requirements for the above section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Summary of Work.
 - 2. Submittals, Analysis and Device Schedules.
 - 3. Record Documents.
 - 4. Operating and Maintenance Manuals.
 - 5. General Electrical Product Requirements.
 - 6. General Electrical Installation Requirements.
 - 7. Electrical equipment coordination and installation.
 - 8. Sleeves for raceways and cables.
 - 9. Sleeve seals.
 - 10. Grout.
 - 11. Common electrical installation requirements.
- B. Provide all work required for complete electrical and ancillary system as indicated on the drawings and in these specifications. This may include, but is not necessarily limited to; panelboards, transformers, cabinets, motor controllers, circuit breakers, fuses, disconnect switches, surge suppression, fire alarm system, Lighting Control System, interior and exterior lighting, parking lot lighting, lamps, relay panels, contactors, controls, wiring devices, wire and cable, grounding and bonding, lightning protection, equipment wiring system, conduit, raceways, boxes, supporting devices, identification, fire stopping, testing, excavating, concrete equipment bases, concrete duct encasements, conduit sleeves and supports, anchors, vibration and sound isolation, access panels, record drawings, installation permits, inspections by governing authorities, electrical work of certain temporary facilities and services, cutting-and-patching work, utility connection coordination, start-up of electrical systems and equipment, training of Owner's operating personnel, operating and maintenance manuals, final cleaning of electrical and similar work.
- C. Except where otherwise indicated, electrical drawings prepared by Engineer (contract drawings) are diagrammatic in nature and may not show locations accurately for various components of electrical systems. It is the intention of the Construction Documents to establish the types and functions of the systems, but not to set forth each and every item essential to the functioning of any system. The Contractor shall make necessary changes or additions as may be reasonably inferred from the construction documents for a complete operating system as required and record these on the record documents at no cost to the Owner.
- D. Contractor shall visit site prior to submitting his proposal and become familiar with the conditions under which the Work is to be performed, and correlate site observations with the

requirements of the Contract Documents. Errors, inconsistencies or omissions discovered shall be reported to the Architect/Engineer at once.

- E. All electrical products and installations shall comply with the latest additions of the following standards where applicable:
1. ADA - AMERICANS WITH DISABILITIES ACT
 2. ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
 3. ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
 4. CBM - CERTIFIED BALLAST MANUFACTURERS
 5. ETL - ELECTRICAL TESTING LABORATORIES
 6. FM - FACTORY MUTUAL
 7. ICEA - INSULATED CABLE ENGINEERS ASSOCIATION
 8. IEEE - INSTITUTE OF ELECTRONICS AND ELECTRICAL ENGINEERS
 9. NEC - NATIONAL ELECTRICAL CODE
 10. NECA - NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION
 11. NEMA - NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
 12. NESC - NATIONAL ELECTRICAL SAFETY CODES
 13. NFPA - NATIONAL FIRE PROTECTION ASSOCIATION
 14. NETA - INTERNATIONAL ELECTRICAL TESTING ASSOCIATION
 15. OSHA - OCCUPATIONAL SAFETY AND HEALTH ASSOCIATION
 16. UBC - UNIFORM BUILDING CODE
 17. IBC – INTERNATIONAL BUILDING CODE
 18. ICC – INTERNATIONAL CODE COUNCIL
 19. IECC – INTERNATIONAL ENERGY CONSERVATION CODE
 20. ISO – INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
 21. UNDERWRITERS LABORATORIES, INC.
 22. TAS – TEXAS ACCESSIBILITY STANDARDS
 23. STATE ENERGY CONSERVATION CODE
 24. MUNICIPAL OR COUNTY CODES. In the event of conflicts between codes or standards, the more stringent requirements shall govern.
- F. All work and materials shall be warranted as indicated in Division 1.
- G. Contractor is responsible for filing and paying for all fees and obtaining necessary permits and certificates of inspection, and shall deliver all certificates of inspection to Owner, and include copies with maintenance manuals.

1.3 DEFINITIONS

- A. NRTL: Nationally Recognized Testing Laboratory, including United Laboratories (UL) and Intertek (ETL).

1.4 SUBMITTALS

- A. General Submittal Requirements:
1. All submittals shall be in accordance with Division 1 requirements.
 1. Submit number of copies indicated in Division 1 or 6 copies, whichever is greater.
 2. Applicability: Wherever it is indicated that shop drawings, samples, manufacturer's brochure, certification, test, copy of standard operating instructions, manual, extra stock, or warranty is required, appropriate submittal is required regardless of whether it is specified as "submittal"; Engineer's decision shall be final.
 3. Do not purchase equipment until submittals have been reviewed by Engineer with no exceptions taken.
 4. Signed Commitments: Do not proceed with transfer of electrical systems to Owner for operation until warranties, performance certifications, maintenance agreements and

- similar commitments to be signed by Contractor and other entities have been executed and transmitted to Engineer (for Owner's records).
5. Response to Submittals: Where standard product data have been submitted in fulfillment of project requirements, it is recognized that submitter has already determined that products fulfill specified requirements, and that submittals are for engineer's information only, but will be returned without action where observed to be non-complying with requirements. Where uniquely prepared information is submitted, it is recognized to represent preparer's interpretation or solution to specified requirements, subject to Engineer's concurrence and appropriate action as indicated in Division 1.
 6. Submittals shall be signed by the General Contractor and Subcontractor responsible for this work.
 7. The Engineer's review of submittals is solely for general conformance with the design concept. The Engineer's review does not relieve the Contractor from total responsibility for quantities, errors, omissions or compliance with the intent of the original contract documents. Review and approval by the Contractor is required before fabrication, shipment or installation.
- B. Substitutions: Electrical submittals are not opportunities for gaining acceptance of substitutions. Any variance from the contract documents shall be identified in accordance with Division 1 requirements. Substitutions will be reviewed only for those reason identified in Division 1 and only if the procedures identified in Division 1 are followed. Any variances from the contract documents in the submittals which are not identified by the Contractor in accordance with the procedures of Division 1 and subsequently not identified by the Engineer's review shall be corrected by the Contractor at no cost to the Owner. Substitution request would only be considered if product is equal or better than what listed. No substitution will be allowed for fire alarm system and any electrical products and equipment.
- C. Coordination Drawings: Prior to any submittals being reviewed, the Contractor shall provide the coordination drawings indicated in Division 1. In accordance with Division 1, the coordination drawings shall show work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. The coordination drawings shall be to a scale of 1/4" = 1'-0" or larger. Coordination drawings in the buildings shall include but not be limited to all Electrical rooms with size and location, major electrical equipment and accessories, switchgear and clearances, HVAC ductworks in rooms, plumbing, air grilles, light fixtures, communications equipment, access panels, transformers, switchboards, panelboards, control panels, fire alarm equipment, code clearances for equipment, manufacturers required maintenance clearance for equipment, concrete equipment pads, exterior wall penetrations, foundation penetrations, and fire rated wall penetrations.
- D. Short Circuit Analysis: Prior to any electrical submittals being reviewed, the Contractor shall perform short-circuit analysis of the specified electrical power distribution system. This analysis shall include:
1. A calculation of the maximum RMS symmetrical three-phase short-circuit current available at each panel location in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short circuit currents shall be calculated with the aid of a computer. The Contractor shall obtain necessary information from the utility to do this prior to furnishing equipment and coordinate with manufacturer to meet the greater of minimum required rating and rating indicated on Drawings.
 1. Appropriate motor short-circuit contribution such that the calculated values will represent the highest short-circuit current to which the equipment will be subjected under fault conditions.

2. A tabular computer printout of equipment supplied by the electrical ratings of the electrical equipment supplied by the electrical manufacturer, the calculated short-circuits currents, X/R ratios, and notes regarding the adequacy or inadequacy of the equipment.
 3. A computer printout of input circuit data including cable lengths, number of cables per phase, cable impedance values, insulation types, transformer impedances, X/R ratios and other circuit information as related to the short-circuit calculations.
 4. A bus-to-bus computer printout listing the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current. This printout shall have an accompanying printout explaining how to interpret the short-circuit results.
 5. A computer-generated system one-line diagram clearly identifying individual equipment buses, bus numbers used in short-circuit analysis, cable and bus connections between the equipment and calculated maximum short-circuit current at each bus location.
 6. A discussion section evaluating the adequacy or inadequacy of the equipment, with recommendations as required for improvements to the system.
 7. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements.
 8. Six (6) bound copies of the completed short-circuit analysis sealed by a Texas Licensed Professional Electrical Engineer shall be submitted for the Engineer to review.
- E. Protective Device Time-Current Coordination Analysis: Prior to any electrical equipment submittals being reviewed, the Contractor shall perform a protective device time-current coordination analysis of the specified electrical power distribution system. This analysis shall include:
1. A determination of settings, ratings, or types for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with:
 - a. System protection shall be more important than service continuity. The time current condition analysis shall be performed with the aid of a computer.
 2. Computer generated log-log plots containing the time current characteristics of over-current devices. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination. The log-log plots shall include transformer ANSI withstand point and inrush currents of transformers where appropriate. Series rated devices shall not be acceptable.
 3. Computer printouts to accompany the log-log plots containing descriptions for each of the devices shown on the plot, setting of the adjustable devices, device numbers to simplify locations of the devices on the system one-line diagram and short circuits where shown.
 4. A tabular computer printout of the suggested settings of the adjustable over-current protective devices, the equipment where the devices are located, the device number corresponding to the device on the system one-line diagram and the number of the time-current log-log graphs where they are illustrated.
 5. A computer generated system one-line diagram clearly identifying individual equipment buses, the bus numbers, the device numbers and the maximum available short-circuit at each bus which shall include short-circuit current motor contributions.
 6. A discussion section evaluating the degree of system protection and service continuity with over-current devices, with recommendations as required for increased protection or coordination.
 7. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements.
 8. Six bound copies of the completed protective device time-current coordination analysis for the engineer.
- F. Over-current Device Schedule: Prior to any electrical submittals being reviewed, Contractor shall provide a schedule for each piece of equipment required by Divisions 11, 14, 21, 22, 23, 25, 27, and 28 in coordination with subcontractors providing equipment under these sections. Submittals shall reflect required coordination by having related Contractor's signatures on the

submittals. This means that electrical requirement for chiller as an example, shall be coordinated by BOTH Electrical and Mechanical subcontractors, and Over-Current Device Schedule submitted shall be signed by both Contractors. For each piece of equipment actually supplied, the schedule shall indicate the full load amps (FLA), the minimum circuit amps (MCA), and the maximum over-current protection device (MOCPD). The schedule shall also indicate if the equipment is required to be protected by fuses only, thermal magnetic breaker only, HACR breakers only or any combination thereof. It shall also indicate if the equipment requires single point or multiple point of connections and how the Contractor is proposing to meet the requirements if different than construction documents. It shall explicitly indicate the required number of conductors, disconnect switch sizes and numbers (if required), and acceptable conduit sizes and number. These modifications shall be reflected in the electrical equipment submittal. Required changes shall be made at no cost to the Owner.

G. After the coordination drawings, short circuit analysis coordination analysis and over-current device schedule are submitted, the products in Division 26 shall be submitted in the groups identified below. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other trades. Submittals for each group will be returned without review unless all sections are included. Sections will not be reviewed separately. At the Engineer's discretion, when a re-submittal is required for one section, any other sections within each group may require re-submittal. Contractor shall expedite submittals and re-submittals as required to allow for the Engineer's review time specified in Division 1. The groups of equipment shall be divided as follows:

1. Raceways, Conductors and Miscellaneous Equipment
 - a. Fire stopping
 - b. Conduit
 - c. Raceways, Multi-outlet Assemblies, Wireways and Auxiliary Gutters
 - d. Wires and Cables
 - e. Outlet Boxes
 - f. Wiring Devices
 - g. Cabinets and Enclosures
 - h. Grounding and Bonding
 - i. Supporting Devices
 - j. Electrical Identification
 - k. Lightning Protection Systems
2. Distribution Equipment
 - a. Distribution Switchboards
 - b. Enclosed Switches
 - c. Dry Type Transformers
 - d. Distribution Panelboards
 - e. Branch Circuit Panelboards
 - f. Enclosed Motor Controllers
 - g. Motor Control Center
 - h. Variable Speed Drives
3. Electrical Controls
4. Lighting Fixtures
 - a. Interior and Building Lighting Fixtures
5. Specialty Systems
 - a. Transient Voltage Surge Suppression
 - b. Fire Alarm System
 - c. Intercom System
 - d. Cable TV System
 - e. Local sound reinforcement System
6. Testing

a. Field Electrical Testing

- H. Shop Drawings: Prepare electrical shop drawings to accurate scale except where diagrammatic representations are specifically indicated. Show clearance dimensions of critical locations, and show dimensions of spaces required for operation and maintenance of equipment. Show conduit layouts and wire/cable connections and other electrical service connections and show interfaces with other work, including structural support. Indicate by note, portions of electrical work shown on shop drawings which deviates from indication of work in contract documents, and explain reasons for deviations. Show how such deviations coordinate with interfacing deviations on shop drawings for other portions of work, currently or previously submitted. Show wiring diagrams, erection, setting, weights, capacities, speeds, outputs, consumption, efficiencies, voltages, amperages, hertz, phases, noise levels, etc.
- I. Samples: Engineer's review of required sample submittals will be limited to observation of general type, pattern, and finish; and will not include testing and inspection of submitted samples, except for those specifically indicated for that purpose in the contract documents. Compliance with specified requirements remains the exclusive responsibility of the Contractor.
- J. Manufacturer's Data: Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which variations are to be provided. Delete or mark-out all portions or pre-printed data which are not applicable. Where operating ranges are shown, mark data to show portions of range required for project application. Expansion or elaboration of standard data to describe non-standard product must be processed as shop drawing data to describe non-standard product. For each product include manufacturer's production specifications, installation or fabrication instructions, nearest source of supply (including telephone number), sizes, weights, speeds, operating characteristics, ratings, conduit and wire/cable connection sizes and locations, statements of compliance with required standard and governing regulations (include manufacturer's signed statements if not covered in printed data), performance data (where applicable) and similar information needed to confirm compliance with requirements.
- K. Manufacturer's Certification: Each manufacturer is required to review the system design as related to the proper operation of his equipment, including electrical requirements, automatic controls, mechanical systems and equipment locations and related items. With shop drawings submit a letter from the manufacturer stating that his equipment will operate satisfactorily under the design conditions. The manufacturer's representative shall review the final installation at the site and submit a second letter stating that the equipment operates satisfactorily as installed. Furnish certification for the systems listed in each section of Division 26.
1. Test Reports: The Contractor for various sub-systems shall submit proposed testing procedure for their system, subject to review and approval and owner acceptance. The contract will not be declared to be substantially complete until the functional operation of the subsystems have been demonstrated and verified and reports have been provided, reviewed and accepted. The project will not be declared substantially complete until the following has taken place:
 2. The "As-Built" drawings have been submitted, reviewed, and accepted by OWNER CM-PA/Bond Office.
 3. The various systems have been commissioned and accepted. This will include the following systems:
 - a. Building Fire Alarm System
 - b. Clock System
 - c. Television Distribution System
 - d. Building Computer Network
 - e. Surveillance and Security System
 - f. Intercom/Telephone

- L. Submit test report signed and dated by firms performing test, and prepare in manner specified in standard or regulation governing test procedure as indicated. Provide notarized executions on test reports.
- M. Warranties: Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. A minimum of one-year warranty period is required for all materials and equipment. Warranty period starts upon first beneficial use or acceptance by OWNER whichever comes first.
 - 1. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; names, addresses and telephone numbers and procedures for filing a claim and obtaining warranty services.
 - 2. Where pre-printed and published warranty includes substantial deviation from required warranty (as judged by Engineer), product is automatically disqualified from use on project, except where manufacturer prepares and issues specific project, warranty on product, stating that it is in lieu of published warranty, and is executed by authorized officer, and complies with requirements.
- N. Load Current and Overload Relay Heater List: Compiled by Contractor after motors have been installed. Arrange to demonstrate selection of heaters to suit actual motor nameplate full load currents.

1.5 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:
 - 1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; access panels; and fuse and circuit breaker size and arrangements.
 - 1. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 2. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 3. Underground cabling and conduits both interior and exterior, drawn to scale and fully dimensioned.
 - 4. Work concealed behind or within other work, in a non-accessible arrangement.
 - 5. Mains and branches of wiring/cabling systems, with switchboards, panelboards, and control equipment and devices located and numbered with terminals and connections located, and with equipment requiring maintenance located.
 - 6. Grounding systems including primary, secondary and special.
- B. Execution: Each installer or other entity responsible for recording installed work shall record firm name, signature and date on each drawing so marked.
- C. Prior to transmittal of corrected drawings, obtain three (3) sets of blue-line prints of each drawing in each set, regardless of whether corrections were necessary, and include in transmittal (two (2) sets are for Owner's use, and one (1) is for Engineer's records).

1.6 OPERATING AND MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, provide the following.
- B. Submit sets prior to final inspection, in electronic PDF format.

C. Contents:

1. Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractor, and major equipment suppliers.
1. Operation and maintenance instructions, arranged by system.
2. Project documents and certificates.
3. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
4. Manufacturer's original printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. (Copies are not acceptable).
5. Maintenance procedures for routine preventative maintenance and troubleshoot; disassembly, repair, and re-assembly; aligning and adjusting instructions.
6. Servicing instructions and lubrication charts and schedules.
7. Warranty information including any corrections made during submittals.
8. Replacement parts list.
9. List of tools and accessories needed for maintenance.

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
1. To provide for ease of disconnecting the equipment with minimum interference to other installations.
2. To allow right of way for piping and conduit installed at required slope.
3. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 GENERAL MANUFACTURER QUALIFICATION

- A. Production Experience: For all electrical equipment, manufacturer shall be firm with not less than five (5) years successful production experience. Experience means production of units similar to those required, as judged by Engineer. Comply with longer-period experience requirements specified in other Division 26 sections of these Specifications. Product shall be new and design for quiet, vibration free operation.

2.2 GENREAL ELECTRICAL PRODUCT REQUIREMENTS

- A. Standard Products: Provide not less (quality) than manufacturer's standard products as specified by published product data. Do not assume that available off-the-shelf condition of product complies with requirements; as example, specific finish or color may be required.

- B. Unencumbered Purchases: Avoid purchases and use of products which are encumbered with questionable title transfers, patent rights, trade union restrictions, code compliance, non-listings as "approved products" for compliance with governing regulations, duties due, embargoes and similar possible encumbrances, claims or seller's interest.
 - 1. Purchasing: Do not purchase specific electrical materials and equipment for project until completion of submittals.
 - C. Condition of Products: Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at time of installation. Do not use units, which have been subjected to destructive testing, or other high-limits testing except where pre-tested products are specified. Comply with Division 1 requirements for exposure or visual display limitations against trademarks and manufacturer's names. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of products, or required by governing regulations.
 - D. Assembly and Testing: To greatest extent possible and unless otherwise indicated, complete fabrication, assembly, finishing and testing of products prior to delivery to project. Notify Engineer not less than one week in advance of pre-installation testing to be performed in response to project requirements. Engineer reserves right to be present at tests of electrical products; however, neither their absence nor presence relieves the Contractor of responsibility for compliance with requirements.
 - E. Uniformity: Where multiple units of generic product are required for single major system of electrical work, e.g., cable trays, lighting systems, provide identical products by same manufacturer, without variations.
 - 1. Limitations: Product/manufacturer uniformity does not apply to conduit and fittings, 600V electrical wire, sheet metal, steel bar stock, welding rods, solder, factory applied paint between different systems, fasteners, motors for unlike equipment units, and similar items used in work, and except as otherwise indicated.
 - F. Product Compatibility, Options: Where more than one product selection is specified, selections are Purchaser's or Installer's options, except do not provide products which are not compatible with previously purchased or installed products which must interface with selections. Provide electrical adaptations as needed for interfacing of selected products in work.
 - G. Quality Assurance: Provide products listed by and installed in accordance with all references in each section under quality assurance any other applicable requirements.
 - H. Elevation Requirements: Electrical equipment provided shall perform at mean elevation of 1000 feet above sea level.
 - I. Listing: Provide products that are listed by a NRTL.
- 2.3 SLEEVES FOR RACEWAYS AND CABLES
- A. Retain one of first two paragraphs below for penetrations through exterior walls above and below grade.
 - B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
 - C. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.

- D. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.4 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2.5 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 GENERAL ELECTRICAL INSTALLATIONS

- A. The Contractor shall provide all necessary items for a complete operating system.
- B. Provide all electrical systems required by and in accordance with Division 26.
- C. Perform work for other divisions as required for electrical installations or coordinate such work with other trades which includes but is not necessarily limited to:
 - 1. Division 1: Cutting and Patching, Temporary Controls, Submittals, Facility Start-up, Contract Close Out, Record Documents, etc.
 - 2. Division 2: Trenching, Backfilling, Compaction, Demolition, etc.
 - 3. Division 3: Concrete Formwork.
 - 4. Division 5: Metal Fabrications.
 - 5. Division 6: Rough Carpentry.
 - 6. Division 7: Joint Sealers and Fire Stopping
 - 7. Division 8: Electric Door Hardware and Access Doors
 - a. Deviation: Contractor is encouraged to coordinate and combine electrical access with mechanical access, and has the option to not add electrical access panels if acceptable coordination can be achieved.
 - 8. Division 9 - Painting: In addition to Division 9, paint electrical equipment factory applied paint surfaces damaged during installation with paint purchased from equipment manufacturer to match each damaged surface.
 - 9. Divisions 11 and 13: Laboratory Furniture, Electronic Systems, Intercoms, etc.
 - 10. Division 15 for motors, controls, accessories, and connections.
- D. Verify all dimensions by field measurements.
- E. Arrange for chases, sleeve, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- F. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

- G. Where mounting heights or locations are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom and working clearances possible, but not less than required by Code.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings and manufacturer's instructions, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
- I. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- J. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- K. Install J-boxes for all other equipment requiring access or maintenance, which are concealed behind surfaces so that these devices can be serviced from the access panels. Where practical, group J-boxes and equipment so that they can be accessed from the same panel or door. If additional panels are needed, panels must be submitted for approval.
- L. Cut, remove and legally dispose of selected electrical equipment, components, and materials, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.
- M. The A/E reserves the right to make relocations up to 6 feet of outlets, boxes, cabinets, lighting, etc. before finished rough-in at no cost to the Owner.
- N. Contractor shall notify design prime consultant and associated owner representative when he requests an inspection by the City Inspector.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protection and Identification: Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identification; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in dry, well ventilated, indoor space, except where prepared and protected by manufacturer specifically for exterior storage.

3.7 DAMAGED EQUIPMENT

- A. The following will be rejected (even after final installation) and must be replaced with same as original at no cost to Owner:
 - 1. Dented, deformed, stepped-on, or otherwise physically damaged enclosures.
 - 2. Stripped cover plate screws and the holes they screw into.
 - 3. Door hinges that do not operate smoothly.
- B. The following will require field repair to original condition:
 - 1. Minor scratches to equipment enclosure finishes.

3.8 TEMPORARY WIRING

- A. The electrical Contractor shall arrange for and provide all necessary equipment, outlets, temporary lights, metering and communications as required during the construction period for temporary electrical service to the project.
- B. It shall be the responsibility of the electrical Contractor to consult with all other trades on the project in order to determine the voltage of temporary electrical service required to operate the construction equipment to be employed and to provide such services to the project.
- C. It shall be the responsibility of the electrical Contractor to make all arrangements for, and to furnish and install, any and all temporary wiring, switches, and structures which may be required to maintain service continuity during the entire construction period. Temporary power and lights shall be UL listed and shall include a ground wire, a guard and a proper means of support.
- D. All temporary installations shall be performed in accordance with the current edition of the National Electrical Code. All machinery and equipment powered by electricity shall have effective electrical equipment grounding provided with all electrical circuits.

3.9 UTILITIES

- A. This Contractor shall examine the site and shall verify, to his own satisfaction, the location and elevation of all utilities, and shall adequately inform himself as to their relation to the work before entering into a contract.
- B. Existing utility lines shown within the scope of this project to be abandoned or removed shall be performed as directed by the Owner, and/or utility companies.
- C. Existing utility lines not shown on the drawings but encountered during construction shall be protected, relocated or capped as directed by the Owner, and/or utility companies. All precautions shall be exercised to prevent damage to existing lines not shown, but should work become necessary, it must be authorized prior to execution except in an emergency situation.
- D. Before beginning excavations of any nature whatsoever, the Contractor shall make an attempt to locate all underground utilities of every nature occurring within the bounds of the area to be

excavated. The Contractor shall then proceed with caution in his excavation work so that no utility shall be damaged with a resultant loss of service.

- E. Should any damage result to any utility through the Contractor's negligence or failure to comply with the above directive, he will be liable for such damage and for all expense incurred in the expeditious repair or replacement of such damaged utilities.
- F. Repair of damaged utilities shall be to a condition equal to or better than the adjacent undamaged portion of such utility and to the complete satisfaction of the Owner and/or utility companies.

3.10 EXCAVATION

- A. The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated and/or required for the installation of all portions of the utilities systems. All excavated materials not required for fill or backfill shall be removed. All excavation shall be made by open cut. The banks of trenches shall be kept as nearly vertical as practicable and where required shall be properly shored and braced. Trenches shall be at least 12" wider and not more than 16" wider than the outside diameter of the conduit, and shall be excavated true to line so that a clear space greater than 6" and less than 8" in width is provided on each side of the conduit or duct bank.
- B. Except at locations where the excavation of rock from bottom of trenches is required, care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum over-depth of 4" below the trench depths indicated on the drawings or as specified. The over-depth rock excavation shall be back-filled with loose, moist earth and thoroughly tamped.
- C. Whenever wet or otherwise unstable soil that is incapable of supporting the conduit duct bank, pole base or pad is encountered in the trench bottom, such soil shall be removed to a depth required. The trench bottom shall be filled with coarse sand, fine gravel, or other suitable material.
- D. Backfill with earth under pole bases, pads or other buried structures will not be permitted, and any unauthorized excess excavation below the levels indicated for foundation of such structures shall be filled with sand, gravel or concrete at the expense of the Contractor.
- E. All grading in the vicinity of excavations shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or by other approved method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from the edges of trenches to avoid overloading and to prevent slides or cave-ins.

3.11 BACK-FILLING

- A. Trenches shall not be back filled until all required tests are performed and until the utilities systems as installed conform to the requirements specified.
- B. Trenches shall be carefully back filled with the excavated materials approved for back filling. This material shall consist of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials, free from large clods of earth or stones, deposited in thoroughly and carefully tamped 6" layers, until the conduit has a cover as specified. Broken rock, broken concrete or pavement, and large boulders shall not be used as backfill material.

- C. Settling the backfill with water will be permissible and will be a requirement when so directed.
- D. Any trenches across roadways or other areas to be paved shall be back filled with flowable fill (CLSM) or approved equal (ashes combined with concrete) in such manner as to permit the rolling and compaction of the filled trench. Together with the adjoining earth, shall provide required bearing value so that paving of the area can proceed immediately after the backfilling is completed.

3.12 CLOSEOUT PROCEDURES

- A. General Coordination: Refer to Division 01 sections and individual Specification sections for coordination of electrical closeout work with variable loads on electrical system. Coordinate taking of final photographs (if any) with electrical closeout, so that maximum detail of work as finally accepted is shown. Sequence closeout procedures properly, so that work will not be endangered or damaged, and so that every required performance will be fully tested and demonstrated.
- B. System Performance Test Runs: Coordinate test runs of electrical systems with test runs of equipment served thereby (heating, air conditioning, plumbing, etc.). Check each item in each system to determine that it is set for proper operation. With Owner's Representative and Engineer present, operate each system in test run of appropriate duration to demonstrate compliance with performance requirements. During or following test runs, make final corrections or adjustments of systems to refine and improve performances where possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements. Provide testing or inspection devices as may be reasonably requested for Engineer's observation of actual system performances. Demonstrate that controls and items requiring service or maintenance are accessible.
- C. Cleaning and Lubrication: After final performance test run of each electrical system, clean system both externally and internally. Comply with manufacturer's instructions for lubrication of both power and hand-operated equipment, and remove excess lubrication. Touch-up minor damage to factory-painted finishes and other painting specified as electrical work; refinish work where damage is extensive.
- D. General Operating Instructions: In addition to specific training of Owner's operating personnel specified in individual Division 26 work sections, and in addition to preparation of written operating instructions and compiled maintenance manuals specified in Division-26 Sections and elsewhere in these specifications, provide general operating instructions for each operational system and equipment item of electrical work. Coordinate instructions with instructions for mechanical work, elevators and other equipment where associated with electrical systems or equipment.
 - 1. Describe each basic electrical system and functioning of its control system.
 - 2. Explain identification system, mimic diagrams, signals, actuators, sensors, alarms, telecommunication systems, and similar audio/visual provisions.
 - 3. Describe interfaces with mechanical equipment, including interlocks, sequencing, start-up, shut down, emergency, safety, system failure, security and similar provisions.
 - 4. Outline basic maintenance procedures and major equipment turnaround requirements, including adjustments to optimize output and efficiency of electrical system.
 - 5. Display and conduct "thumb-through" explanation of maintenance manuals, record drawings, spare part inventory, storage of extra materials, meter readings and similar service items.

- E. Construction Equipment: After completion of performance testing and Owner's operating instructions and demonstrations, remove installer's tools, test facilities, construction equipment and similar devices and materials used in execution of work but not incorporated in work.
- F. Security and Protection: During electrical work closeout phase, meet with Owner's operating representative frequently (daily where necessary) and agree upon status of operational responsibility for electrical systems (including securing provisions to prevent unauthorized operations, and including protective measures to ensure that systems are not neglected or misused).

PART 4 - CONTINUED SYSTEM OPERATIONS

- A. Acceptance and Continued Services: Coordinate Owner's take-over of electrical systems with take-over of mechanical systems, including the provision of skilled electrical operating and maintenance personnel until time Owner's personnel take over operation of entire mechanical and electrical plant. Contractor shall continue consultation and services (beyond take-over date) for electrical systems, matching required continued services on associated mechanical systems and equipment.

END OF SECTION 26 05 00

26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600V and less.
2. Connectors, splices, and terminations rated 600V and less.
3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:

C. List below only products and equipment that the reader might expect to find in this Section but are specified elsewhere.

1. Division 27.

1.3 DEFINITIONS

A. Retain abbreviations that remain after this Section has been edited.

B. EPDM: Ethylene-propylene-dieneterpolymer rubber.

C. NBR: Acrylonitrile-butadiene rubber.

D. MCM: Thousand circular-mils.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Coordinate paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

C. Qualification Data: For testing agency.

D. Retain paragraph below if Contractor is responsible for field quality-control testing.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Retain first paragraph and subparagraph below if Contractor is required to provide services of an independent testing agency in Part 3 "Field Quality Control" Article. Qualification requirements

supplement those specified in Division 01 Section "Quality Requirements", which also includes the definition for NRTL.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. UL Compliance: Provide components which are listed and labeled by UL under the following standards.

1. UL Std. 83 - Thermoplastic-Insulated Wires and Cables.
2. UL Std. 4 - Armored Cable
3. UL Std. 1569 - Metal-Clad Cables
4. UL Std. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
5. UL 13 - Power limited circuit cables.
6. UL 1666 - Test for flame propagation height of electrical and optical-fiber cables installed vertically in shafts.
7. UL 910 - Test for flame propagation and smoke density values for and optical fiber cables used in spaces environmental air.
8. UL 1685 - Vertical tray fire propagation and smoke release test for and optical fiber cables.

F. NEMA WC-5: Thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.

G. Federal Specifications

1. J-C-30B (1) cable and wire, electrical (power, fixed installation).

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers, 600 Volt or Less Wire and Cable: Subject to compliance with requirements, provide products by one of the following:

1. Carol
2. South wire.
3. Triangle PCW
4. American Insulated Wire Corp
5. BFCC Brand
6. Senator Wire and Cable

7. Encore Wire Corporation

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, XHHW, UF, USE and SO. All conductors are to be Copper wire or cable insulated for 600 V, color coded for the entire length. Use of electrical tape for marking is strictly prohibited.

1. Conductors shall be provided with insulation types indicated explicitly on drawings, and substitution is NOT acceptable without Engineer's approval.

2. Wiring BX and MC will not be acceptable for use on this project. MC may be used for light fixture whips only.

3. Where insulation type is not explicitly identified on drawings, branch circuit and feeder circuit conductors shall have THHN-THWN dual-rated insulation.

D. Multi-conductor Cable: Comply with NEMA WC 70 for armed cable, Type AC, metal clad cable, Type MC, mineral-insulated, sheathed cable, Type MI with ground wire.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.

3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Copper:

1. Solid for #10 AWG and smaller;
2. Stranded for #8 AWG and larger.

B. Aluminum:

1. Use only for distribution or service feeders where explicitly indicated on Drawings.
2. Use AA-8030 alloy only.
3. Stranded only
4. Minimum size: 250 MCM.
5. Provide compression lugs.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2 single conductors in raceway, unless specifically noted otherwise on Drawings.

B. Feeders to Switch Boards, Distribution-Class Panels, and Motor Control Centers located in central plant or main electrical room: Type XHHW-2 single conductors in raceway, unless specifically noted otherwise on Drawings.

C. Feeders to Distribution-Class Panels, Lighting-Class Panels, and distribution equipment located in any other area: Type THHN/THWN-2 dual-rated insulation conductors in raceway, unless specifically noted otherwise on Drawings.

D. Feeders to Emergency Equipment: Type RHW-2, unless specifically noted otherwise on Drawings.

E. Branch Circuits: Type THHN/THWN-2 dual-rated insulation conductors in raceway, unless specifically noted otherwise on Drawings.

1. Lighting Fixture Tails: A maximum of 6'-0" length of multi-conductor cable may be used for lighting fixture connection from above-ceiling junction boxes with Code-required support and minimum of one support point between junction box and fixture.

2. Wiring Devices: Multi-conductor cable is not acceptable for use in connection of wiring devices and associated boxes.

3. Equipment: Multi-conductor cable is not acceptable for use in connection of equipment by any Division.

F. Control Circuits: Type THHN/THWN-2 in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Do not re-pull wires/conductors that been used. Do not use rope hitches for pulling attachment to wire or cable.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- G. All wire shall be installed in conduit or raceways.
- H. All circuits shall have a hot, neutral and green ground wire unless otherwise indicated.
- I. Provide #12 conductors and #12 grounds minimum to all 20 amp devices unless otherwise indicated.
- J. Provide #10 conductors and #10 grounds minimum to all 30 amp devices unless otherwise indicated.
- K. Provide #10 minimum conductors for 120/208V 20 amp circuits for which the distance from the panelboard to the first device is greater than 100 feet.
- L. Provide #10 minimum conductors for 277/480V 20 amp circuits for which the distance from the panelboard to the first device is greater than 200 feet and for all general lighting circuits with continuous load greater-than-or-equal-to 3.0 kVA.
- M. Do not install wires in conduit until entire system of conduit and outlet boxes is permanently in place.
- N. Exercise care when installing wire in conduit so as to prevent injury to the conductor insulation. Mechanical means of pulling shall not be used unless approved. Conductors shall be pulled using UL non-flammable listed lubricant when necessary. Do not re-pull wires/conductors that been used.
- O. Whenever wiring leaves the conduit and terminates at a terminal board, the wiring shall be formed and laced with plastic wire ties. Conductors are to be installed neat, order and workmanlike manner and also comply per NEC 70; Article 312.
- P. In the event circuits feed through outlet boxes, provide splice and pigtail for device connection, with sufficient slack to pull splice out of box at least 6 inches (for inspection). Terminate the conductors around the terminal screws not at the back of the receptacle.
- Q. Coordinate cable installation with other Work.
- R. Pull conductors simultaneously where more than one is being installed in same raceway.
- S. Splices:
 - 1. Branch Circuits: Keep conductor splices to a minimum.
 - 2. Motor Branch Circuits: Splices are not allowed in motor branch circuit feeders.

3. Relocation of Existing Lighting-Class Panels: Provide splices to existing branch circuits that are active and will remain in above-ceiling junction boxes sized appropriately for the quantity of conductors. Verify existing branch circuit feeder condition and ampacity and provide new feeders where existing violations exist. Match and extend branch circuit feeders from splice to new panel location and provide new branch circuit breaker as indicated in Panel Schedules to re-feed existing load.
 4. Service Entrance Feeders: Splices are not allowed in any service entrance feeder(s). All conductors must be single length.
 5. Distribution Feeders: Splices are not allowed in any distribution feeder(s) including, but not limited to feeders between switch boards, distribution-class panels, lighting-class panels, motor control centers, transformers, safety switches, and motor controllers and drives.
 6. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced.
 7. Use splice and tap connectors which are compatible with conductor material.
- T. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than no.10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- U. Home Runs: except where specifically indicated, provide lighting branch circuit home runs with not more than three different line conductors and a common neutral in a single raceway for 4-wire, 3-phase systems.
- V. Conductors may be run in parallel in sizes 1/0 through 750 MCM where indicated and provided that all conductors of each phase are the same length and so arranged and terminated as to ensure equal division of the current between all paralleled phase conductors.
- W. Feeders shall be installed in continuous pieces without splice.
- X. Install a separate neutral for each circuit which serves GFCI or isolated ground receptacles.
- Y. Each circuit originating from a GFCI type circuit breaker shall also have a separate neutral.
- Z. Where specifically indicated, for receptacle branch circuits, provide a separate neutral conductor for each line conductor.
- AA. Each circuit serving receptacles where data terminals are used shall have separate neutral.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. Provide Documentation and records all torque terminations.
- B. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack per Section 300.14.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both wall surfaces.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Perform insulation resistance test for all branch and main circuit conductor. Perform test on each conductor with respect to ground and adjacent conductor. Applied potential shall be 1000 volts DC for one minute. Test values shall be evaluated and conductors with values less than 50 megohms shall be investigated. Replace any cable reading less than 1 megohm.

4. Provide torque test for all conductor terminations in transformers, switchboards; disconnect switches, panelboards, etc in accordance with NETA standards. Record test result in accordance with item D below.

5. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each termination of cables and conductors No. 3 AWG and larger. Remove box and equipment covers so terminations are accessible to portable scanner.

a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

b. Record of Infrared Scanning: Prepare a certified report that identifies terminations checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

E. Cleaning:

1. Clean the area around and on top of the equipment.

END OF SECTION 26 05 19

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GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Retain paragraph and subparagraphs below to require that Contractor provide drawings to locate significant grounding features. Division 01 Sections "Project Record Documents" and "Operation and Maintenance Data" require submittals to be included in those documents for use by maintenance forces throughout the life of the Project.

C. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

D. Qualification Data: For testing agency and testing agency's field supervisor.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at ground rings grounding connections for separately derived systems based on NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.
 - c. Records documentation is required for all testing.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience, certified and capability to conduct the testing indicated, that is a member company of the International

Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

A. Acceptable Manufacturers: Erico, Copper weld, Cad weld, Bundy

2.2 CONDUCTORS

A. Insulated Conductors: All conductors are to be Copper wire or cable insulated for 600 V,color coded for the entire length. Use of electrical tape for marking is strictly prohibited.

B. Bare Copper Conductors: Only where specifically indicated on Drawings.

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor and 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn copper.

2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

- D. Ground Rods: Copper-bonded steel; 3/4 inch diameter by 10 feet length; minimum 13 mil plating thickness.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
 - 3. Install grounding conductor from main service to the grounding bus. The minimum conductor used per Article 250.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- B. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

- G. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Use same-manufacturer, matched driving tool to drive ground rods without deformation. "Mushroomed" or otherwise deformed rods will be field-rejected.
2. Replace grounding rods that are deformed at no cost to Owner.
3. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated.
4. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building foundation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 1 Ω .
2. Power Distribution Units or Panelboards Serving Electronic Equipment: 0.5 Ω .
3. Substations and Pad-Mounted Equipment: 0.5 Ω .
4. Manhole Grounds: 5 Ω .

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

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HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. Retain abbreviations that remain after this Section has been edited.
- B. EMT: Electrical metallic tubing.
- C. IMC: Intermediate metal conduit.
- D. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 3. Trapeze hangers. Include Product Data for components.

4. Steel slotted channel systems. Include Product Data for components.
5. Nonmetallic slotted channel systems. Include Product Data for components.
6. Equipment supports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Retain this Article to specify default product requirements for basic supporting devices. Items to be supported include raceways, cables, wireways, cable trays, busways, boxes, cabinets, equipment, and other electrical products. Where support materials or workmanship is unique to a particular product, specify unique features that are the exception to these default requirements in the Section that specifies the product. Coordinate specifications for supporting devices with structural engineer and with Drawings.
- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation.
 - e. Unistrut; Tyco International, Ltd.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 4. Fitting and Accessory Materials: Same as channels and angles except metal items may be stainless steel.
 5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. All conduits shall be installed in uniformity, neat and equal space.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Division 26 "BASIC ELECTRICAL REQUIREMENTS" apply to this Section

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-dieneterpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.
- J. RMC: Rigid metal conduit.
 - 1. RGS: Rigid galvanized steel conduit.
 - 2. RAL: Rigid aluminum conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Manufacturer's instructions: indicate application conditions, limitations, and maximum conductor fill.

C. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

Custom enclosures and cabinets.

1. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.

D. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, UL 5 surface metal electric raceways and fittings Guide RJPR, UL 870 wire way, auxiliary gutters and associated fittings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Acceptable Manufacturers: Triangle, Republic, Carlen, Centex, Western Tube Appleton, Crouse Hinds, Steel City, OOZY. Gender, Race

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. Rigid Aluminum Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Full wall, low-carbon steel with electrogalvanized Zinc coating. Reduced wall not acceptable.
- H. LFMC: Flexible steel conduit with PVC jacket and UL bonded strip for grounding.
- I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 2. Fittings for EMT: compression type.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anamet Electrical, Inc.; Anaconda Metal
 - b. Electri-Flex Co.
 - c. Triangle PCW, Inc
 5. Steel set screw fittings for electrical conduit are allowed only for EMT located in conditioned spaces.
- J. All exterior raceways shall be rigid galvanized steel, unless specifically indicated otherwise on Drawings.
- K. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 3. Arco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.; Pipe & Plastics Group.
 6. Condux International, Inc.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.
- C. ENT: NEMA TC 13.
- D. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated on Drawings.
- E. LFNC: UL 1660.

- F. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: UL 514B.
- H. All underground raceways shall be Schedule 40 PVC, unless otherwise indicated on Drawings.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Arnco Corporation.
 2. Endot Industries Inc.
 3. IPEX Inc.
 4. Lamson & Sessions; Carlon Electrical Products.
 - C. Description: Comply with UL 2024; flexible type, approved for general-use installation.

2.4 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper B-Line, Inc.
 2. Hoffman.
 3. Square D; Schneider Electric.
 4. Tanco.
 5. General Electric.
 6. Westinghouse/Cutler Hammer.
 - C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12, 3R, unless otherwise indicated. Provide electrical wire ways of grades and number of channels for each type of service as indicated. Comply with U.L. 870 "Wire way, Auxiliary Gutters and Associated Fittings." And NEC 366.
 - D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - E. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached that removal is not necessary to utilize the lay-in feature. Connectors shall be grounding bushing, raintight and seal the opening to prevent water getting t inside the boxes, junction, and wireway
 - F. Wireway Covers: Lay-In Wire ways: Construct lay-in wire ways with hinged covers with components UL-listed, including lengths, connectors, and fittings. Select units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings and connectors. Construct units to be capable of sealing cover in closed position with sealing wire. Provide wire ways with knockouts.
 - G. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage. Use paint ANSI61- grey color.

H. Rain tight Wireway: Construct rain tight lay-in wire ways with hinged covers with components UL-listed, including lengths, connectors and fittings. Design units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings and connectors. Construct units to be capable of sealing cover in closed position with sealing wire. Provide wireway units with knockouts only in bottom of troughs.

1. Construction: 16-gauge galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14-gauge parts for 8" x 8" and larger sections. Provide knockouts only in bottom of troughs, with suitable adapters to facilitate attaching to other NEMA 3R enclosures. Do not use gasketing that can rip or tear during installation or would compromise rain tight capability of the trough area and damage wire insulation.

2. Finish: Provide 14-gauge and 16-gauge galvanized sheet metal parts with corrosion-resistant phosphate primer and baked enamel finish. Plate hardware to prevent corrosion.

2.5 NONMETALLIC WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

C. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

D. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

E. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.

3. Multi outlet assemblies shall be used to provide power and/or low potential services as shown on the building plans.

4. The Electrical Contractor shall provide and install all surface metal raceways and appropriate fittings to provide safe and complete installation. The surface metal raceway and fittings shall be the two-piece with receptacles and data outlets (if any) as indicated.

5. When power and data are indicated, the raceway shall afford the capability of being divided into two equal but separate wiring compartments to facilitate installation of power and low potential wiring. "Separate compartments are to be identified by sharply contrasting colors of the interior finish of the divider."

6. A full line of fittings for the surface metal raceway shall be available. This shall include but not limited to elbows (90, internal and external), couplings for joining raceway sections, wire clips for holding

conductors or cables in place, blank end fittings for closing open ends of the raceway, transition connectors to other surface metal communications (if any). All openings shall be grommet. Voice/Data connections (if any) shall be provided with interchangeable LAN adapters. When power and data are indicated, device brackets to install single or two gang devices within the raceway and combination receptacle and telephone outlet covers shall be available.

7. The surface metal raceway and fittings shall meet all requirements of the NEC Article 376 and 380, and shall be listed by Underwriter's Laboratories, Inc. in full compliance with their standard for surface metal raceways and fittings (UL-5).
8. Multi outlet assemblies shall be Wiremold 2000 series with 5-15R simplex receptacles 18" on center.
9. Verify finish color with architect.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Butler Manufacturing Company; Walker Division.
- b. Enduro Systems, Inc.; Composite Products Division.
- c. Hubbell Incorporated; Wiring Device-Kellems Division.
- d. Lamson & Sessions; Carlon Electrical Products.
- e. Panduit Corp.
- f. Walker Systems, Inc.; Wiremold Company (The).
- g. Wiremold Company (The); Electrical Sales Division.

3. Multi outlet assemblies shall be used to provide power and/or low potential services as shown on the building plans.

4. The Electrical Contractor shall provide and install all surface metal raceways and appropriate fittings to provide safe and complete installation. The surface metal raceway and fittings shall be the two-piece with receptacles and data outlets (if any) as indicated.

5. When power and data are indicated, the raceway shall afford the capability of being divided into two equal but separate wiring compartments to facilitate installation of power and low potential wiring. "Separate compartments are to be identified by sharply contrasting colors of the interior finish of the divider."

6. A full line of fittings for the surface metal raceway shall be available. This shall include but not limited to elbows (90, internal and external), couplings for joining raceway sections, wire clips for holding conductors or cables in place, blank end fittings for closing open ends of the raceway, transition connectors to other surface metal communications (if any). All openings shall be grommet. Voice/Data connections (if any) shall be provided with interchangeable LAN adapters. When power and data are indicated, device brackets to install single or two gang devices within the raceway and combination receptacle and telephone outlet covers shall be available.

7. The surface nonmetal raceway and fittings shall meet all requirements of the NEC Article 376 and 380, and shall be listed by Underwriter's Laboratories, Inc. in full compliance with their standard for surface metal raceways and fittings (UL-5).

8. Multi outlet assemblies shall be Wiremold NM2000 series with 5-15R simplex receptacles 18" on center.

9. Verify finish color with architect.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 6. O-Z/Gedney; a unit of General Signal.
 7. RACO; a Hubbell Company.
 8. Robroy Industries, Inc.; Enclosure Division.
 9. Scott Fetzer Co.; Adalet Division.
 10. Spring City Electrical Manufacturing Company.
 11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast or sheet metal rectangular.
- F. Nonmetallic Floor Boxes: Cast or sheet metal rectangular.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
- I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic.
- J. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
1. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 2. Color of Fram and Cover: Green.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC." as indicated for each service.
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Armorcast Products Company.
- b. Carson Industries LLC.
- c. CDR Systems Corporation.
- d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Armorcast Products Company.
- b. Carson Industries LLC.
- c. Christy Concrete Products.
- d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

2.9 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.10 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Plastic. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated in Drawings:
1. Roof-Top Conduit penetrating through roof: RAL.
 2. Aboveground, otherwise: RGS.
 3. Underground:
 - a. Primary conduits to utility pad-mounted transformer: per Utility Standards.
 - b. RNC, Type EPC-40-PVC, direct buried
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC limited to $\leq 72"$.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
 6. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-Deliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.
- B. Comply with the following indoor applications, unless otherwise indicated in Drawings:
1. Exposed, Not Subject to Physical Damage: IMC.
 2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Mechanical rooms.
 - b. Central Plants
 3. Concealed in Ceilings and Interior Walls and Partitions:
 - a. Trade size ≤ 1 -inch: EMT or IMC.
 - b. Trade size > 1 -inch: IMC or RGS.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):
 - a. At dry locations $\geq 84"$ above finished floor to bottom of equipment: FMC
 - b. Otherwise: LFMC.
 5. Damp or Wet Locations: RGS, RAL, or IMC.
 6. Raceways for Communications: EMT or IMC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, galvanized steel in damp or wet locations, unless otherwise noted on Drawings.
- C. Minimum Raceway Size:
1. Power and Fire Alarm:
 - a. Above grade: 3/4-inch trade size.
 - b. Below grade: 1-inch trade size.
 2. Communication:

- a. Above grade: 1-inch trade size.
- b. Below grade: 1-1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions, NEC 366, NEC 380, and NEC 376. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Use flat-head screws, clips, and straps to fasten raceway base to surfaces. Mount plumb and level.

C. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

D. Wireway and Auxiliary Gutter Supports: Provide steel channel as specified in Section 260529.

E. Close ends of wireway and unused conduit openings.

F. Ground and bond raceway and wireway under provisions of Section 260526.

G. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

H. Complete raceway installation before starting conductor installation.

I. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

J. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

K. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

L. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

M. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

Q. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

R. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

S. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

- a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
- b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
- c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
- d. Attics: 135 deg F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

T. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures of 3/4 inch size minimum, equipment subject to vibration, noise transmission, or movement; and for transformers and motors are limited to no more than 4 feet in length.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.

V. Set metal floor boxes level and flush with finished floor surface.

W. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

X. Label and marked all junction boxes, pull boxes, cabinets and conduits leaving and entering any of the boxes, cabinets, and panelboards.

Y. Boxes, junction, pull, cabinets, panelboards and other cabinets shall be rigidly supported with cross bars, Unistrut, all-thread, and any approved that will prevent from moving.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. For Service entrance conduit shall be buried not less 48 inches depth from the top of the conduit to finish grade. For feeder conduit shall be buried not less 36 inches depth from the top of the conduit to finish grade. For branch conduit shall be buried not less 24 inches depth from the top of the conduit to finish grade unless subject to vehicle traffic. The conduits are to be level to the ground.
3. Install backfill as specified in Division 31 Section "Earth Moving."
4. After installing conduit, the conduit shall be supported anchor to the ground with a 3/4inch EMT crossways on every 4 feet intervals then backfill and compact with sand fill. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with 95% compaction.
5. Install manufactured sweep 90-degree RMC duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
6. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 - c. Wrap elbow and first 12" of vertical conduit with Scotch #51 tape (no substitutions), 20-mil thick, 4" wide tape applied two full laps at each start and end of wrap, and 1" overlap for intermediate laps.
 - d. Use special-radius elbow, minimum 24" radius unless otherwise indicated on Drawings.
7. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing those 24 inches o.c. align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
2. Hand-holes and boxes.
3. Manholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, hand-holes, boxes.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

E. Product Certificates: For concrete and steel used in pre-cast concrete manholes and handholes, as required by ASTM C 858.

F. Qualification Data: For professional engineer and testing agency.

G. Source quality-control test reports.

H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store pre-cast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two (2) weeks in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, hand-holes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, hand-holes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and hand-holes, and as approved by Architect.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, and insulators, and associated fasteners in quantities equal to 10 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Refer to Section 26 05 33.
- B. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- C. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT; a division of Cable Design Technologies.
 - 11. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used for supporting ducts during concreting or backfilling.
 - a. Carlon "Snap-N-Stack" combination spacers, interlocking type with 3" separation and reducers as required.
 - 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
 - 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.
- C. Concrete Encasement:
 - 1. Encased in minimum 3" of 5000 PSI conc

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Structural Rating: AASHTO HB 17, H-20.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of hand-hole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering.
7. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.

- b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service.
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

- a. Carson Industries LLC.
- b. Christy Concrete Products.
- c. Nordic Fiberglass, Inc.

2.5 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Structural Rating: AASHTO HB 17, H-20.

C. Comply with ASTM C 858 and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

- a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
- b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
- c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

- a. Type and size shall match fittings to duct or conduit to be terminated.
- b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

D. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.7 UTILITY STRUCTURE ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "COMMUNICATION" for communications, data, and telephone duct systems.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch diameter eye, and 1-by 4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling Eyes in Non-concrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch diameter eye, rated 2500-lbf minimum tension.

G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

J. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.

2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Manholes Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.

N. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Non-concrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated. This includes Electric Utility Primary Duct Banks.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 -PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80-PVC, installed in concrete-encased duct bank, unless otherwise indicated.

D. Wrap all RGS with 2 layers of Scotch wrap which will come in contact with concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.

4. Units Subject to Light-Duty Pedestrian Traffic only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated and 25ft horizontally for above 600v cables.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit and RMC sweep 90 degree elbow at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not more than 6 feet apart. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

- a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
- b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to

flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches (between power and signal ducts).

7. Depth: Install top of duct bank at least 36 inches below finished grade in areas not subject to deliberate traffic, and at least 48 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.

9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.

b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.

4. Install backfill as specified in Division 31 Section "Earth Moving."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

8. Set elevation of bottom of duct bank below the frost line.

9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

- b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

J. Inspection: Prior to or during inspection by Authority Having Jurisdiction for approval and prior to beginning concrete pour, Engineer shall inspect underground duct installation for Engineer approval.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and traffic ways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
4. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

F. Damp proofing: Apply damp proofing to exterior surfaces of manholes after concrete has cured at least three days. Damp proofing materials and installation are specified in Division 07 Section "Bituminous Damp proofing." After ducts have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scars. Damp proof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

I. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and traffic ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.

2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 TRENCHES:

A. Trenches shall be in as straight and direct a line as possible. Routes through unstable soil such as mud, shifting soils, or other hazards should be avoided. Underground conduit systems shall not be installed within 5 feet of any building foundation, swimming pool, etc., except for where service conduit merges to intercept the service equipment.

3.10 PVC INSTALLATION:

A. The ends of the conduit shall be plugged during construction to prevent the entrance of foreign matter.

B. All ends, joints and internal finish of the conduit shall be free of sharp edges or burrs which could damage the cable.

C. All buried joints shall be glued with cement as recommended by the conduit manufactures.

D. Any change in direction between lengths of straight rigid conduit greater than 5 degrees shall be made in electrical sweeps, or with a very gradual sweeping change of direction. Any single run of conduit will contain no more than two 90 degree sweeps. If the secondary runs of conduit are less than 150 feet in length then schedule 80, PVC sweeps are acceptable. For runs of conductor sized 500MCM and larger that exceed 150 feet in length, all sweeps shall be steel. For runs of conductor smaller than 500MCM size and that exceed 200 feet in length, all 90° sweeps shall be steel.

3.11 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

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IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.
9. Identification of Boxes, Junction Boxes and Pull Boxes
10. Identification of Switchboards, Motor Control Center, Panelboard, transformers, disconnecting means, Timer and etc.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions riveted to the metal surface, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high letters on 20-inch centers.
- D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.
- H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
- I. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Write-On Tags: Polyester tag, 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

E. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

A. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
 - B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
 - C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - D. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 - F. Write-On Tags: Polyester tag, 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- A. All conductors shall have the color of insulation for the entire length. Do not use electrical tape to identify the colors. This applies in all sizes.

2.5 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- A. Color and Printing:
 - 4. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 5. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 6. Inscriptions for Orange-Colored Tapes: TELEPHONE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.7 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

E. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. No adhesive is strictly prohibited.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label. No adhesive is strictly prohibited.

C. Punch or drilled riveted Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch. No adhesive is strictly prohibited.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch. No adhesive is strictly prohibited.

E. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

F. Only use drilled/punched riveted label on equipment.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one-piece, self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Identification of Electrical Systems

1. Identify all equipment and circuit breakers.
2. Identify all J-box covers with circuit numbers.
3. On all device wall plates, on inside of plate, indicate panel and circuit number feeding the device.
4. All electrical panels shall have type written panel schedule with room descriptions using actual room signage numbers.
5. Electrical systems shall be identified by painted junction boxes and covers with the following scheme:
 - a. Lighting system: Yellow
 - b. Emergency Power: Red
 - c. 120V Power: Blue
 - d. HVAC system power: Green
6. Electrical panel identification shall include the following:
 - a. Panel Name
 - b. Voltage
 - c. Amperage
 - d. General description such as: Lighting Area A or Power Area C. Refer to Drawings.
 - e. Appropriately colored for emergency.
 - f. Feeder panel designation must be clearly identified.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and hand-holes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - a. New Conductors: Insulation shall be fully and continuously colored. Phase taping is not acceptable.
 - b. Existing Conductors Re-terminated: Use Scotch #35 Vinyl Electrical Color-Coding Tape. No substitutions. Material to be 7-mil polyvinyl chloride (PVC), 3/4"-wide tape with UL-510 rating to 600 VAC. Field apply two full laps without offset at each start and finish, and with 3/8"-over-lap for all intermediate laps using 5 lb/in tension. Start tape no further than 1-1/4" from termination and provide minimum cover length of:
 - 1) #2 AWG and smaller conductors: 6 inches.
 - 2) #1/0 AWG and larger conductors: 8 inches.
 - c. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White
 - 5) Ground: Green
 - d. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.

- 2) Phase B: Purple
- 3) Phase C: Yellow.
- 4) Neutral: Gray/White
- 5) Ground: Green

E. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled: Use punched, drilled riveted label or identifications
- a. Panelboards: Typewritten hard thick card stock paper directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - f. Substations.
 - g. Emergency system boxes and enclosures.
 - h. Motor-control centers.
 - i. Enclosed switches.
 - j. Enclosed circuit breakers.
 - k. Enclosed controllers.
 - l. Variable-speed controllers.
 - m. Push-button stations.
 - n. Power transfer equipment.
 - o. Contactors.
 - p. Remote-controlled switches, dimmer modules, and control devices.
 - q. Battery-inverter units.
 - r. Battery racks.
 - s. Power-generating units.
 - t. Monitoring and control equipment.

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OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent protective device coordination selective studies, and arc flash study. Protective devices shall be set based on results of the protective device coordination selective study.
 - 1. Coordination of series-rated devices is permitted where indicated on Drawings.
 - 2. Retain a qualified professional/engineering firm to assist in the development and implementation of the arc flash and protection coordination selective study.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-selective study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
 - 1. Coordination- selective study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination- Selective Study Report.
 - 4. Electrical One-line diagram

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination- Selective Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision, Fort Bend County representative.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

- D. Comply with IEEE 399 for general study procedures.
- E. The entity shall have an employee that is certified, train and skilled to perform this type of test and be able to interpret the curve and settings.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination selective study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams,

- overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Switchgear and switchboard bus.
 2. Medium-voltage controller.
 3. Motor-control center.
 4. Distribution panelboard.
 5. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium and high voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION SELECTIVE STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- E. Coordination-Selective Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

- A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical systems studied. The calculations shall comply with NFPA-70E 2009, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Articles 130.1 and 130.3 for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.
- B. The arc flash study shall determine the following results for each system mode of operation developed in Section 1.3E (Modeling). The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:
1. Equipment name and voltage
 2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
 3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
 4. Equipment arc gap
 5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.

6. Trip time, opening time, and total clearing time (total Arc time) of the protective device
 7. Worst-case arc flash boundary for each bus/equipment in the model
 8. Worst-case arc flash hazard incident energy in cal/cm² for each bus/equipment in the model
 9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model
 10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance
 11. Indicate "Danger/Hazardous" areas where incident energy is greater than 40 cal/cm² and provide recommendations to reduced arc flash energy levels for these areas
 12. Flag results where 85% arcing current provided worst-case results
 13. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.
- C. Contractor shall provide a detailed arc flash analysis report including as a minimum:
1. Introduction
 2. Methodology
 3. Information Sources
 4. Assumptions including generic substitutions when data cannot be field verified. This type of assumptions shall be documented in the report.
 5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.)
 6. Arc Energy at 100% and reduced currents
 7. IEEE 1584-2002 Considerations.
 8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
 9. Explanation of Data in Arc Flash Hazard Report Tables
 10. NFPA 70E Information
 - a. Shock Hazards with covers removed.
 - b. Shock Hazard Approach Boundaries.
 - 1) Limited Approach Boundary
 - 2) Restricted Approach Boundary
 - 3) Prohibited Approach Boundary
 - c. Arc Flash Hazard Boundaries
 11. Results of Arc Flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
 - a. Working distances.
 - b. Energy Levels
 - c. PPE Requirements
 - d. Recommendations to reduce arc flash hazard energy and exposure.
 12. Arc Flash Hazard Report
 13. 3 Hard Copies
 - a. 1 Electronic Copy in WORD or Excel format and PDF (5.0 or later)
 - b. 1 Electronic copy in latest version of SKM format or its native software
 14. Electronic file for Power System Modeling Software as developed and utilized for this analysis.
- D. Contractor shall provide print labels for all equipment in the system from the project study file. Assume two (2) labels per equipment/bus in your estimate using 4" x 6" labels. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z 535. The labels shall be printable directly from the power system software utilized for the study.

- E. The software shall provide complete integration of the one-line, database, short circuit and PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations are not allowed. The purpose of this section is to ensure that the arc flash hazard calculations comply with NFPA-70E and IEEE-1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the compliance with the OSHA requirements and NFPA 70E mandates. This model will serve as an integral part of Fort Bend County safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E Article 130.1(A)(2) for each electrical equipment in the facility.
1. Arc flash calculations shall be performed with enhanced IEEE-1584 equations, which eliminate voltage discontinuities and the non-conservative/average results of the standard equations. The purpose of this requirement is to ensure that the calculated incident energies are closer to actual test results insuring a conservative calculation minimizing personnel risk.
 2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time.
 3. The arc flash calculations shall include arc flash boundary, incident energy, PPE requirements, and working distances.
 4. The arc flash calculations shall include calculations for all operating modes to ensure the worse arc flash magnitude.
 5. The arc flash calculations shall provide integral "Work Tasks" for the listed equipment types. The tasks shall be derived from 70E Table 130.7(C)(9)(a) and be specific to the equipment type. Listed equipment types shall include:
 - a. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 100-200 volt equipment.
 - b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 200-1000 volt equipment.
 - c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 1.0-5.0 kV equipment.
 - d. Switchgear, MCC, VFD, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 5.0-15.0 kV equipment.
 - e. Interrupting Switch, Conductor, and Open Air for 138 kV equipment.
 6. Work Tasks shall have a user-defined library that provides the following customizable features for each work task:
 - a. Work Tasks for each specific equipment type and voltage range
 - b. Working distance units English or Metric
 - c. Work distance for each task
 - d. V-rated gloves and tool requirements
 - e. Job description and procedures
 - f. Safe work practices description
 - g. Hazard Risk Category (HRC) reduction - HRC reduction can only be used based on a documented risk assessment as an integral part of a safety program.

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LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy sensors.
4. Lighting contactors.
5. Emergency shunt relays.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Provide Settings requirements available from the Owner standpoint.
3. Provide the software that will support the lighting controllers.
4. Software must have the ability to detect outages or no power to a branch circuit and graphic indicators.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
2. Leviton Mfg. Company Inc.
3. Lightolier Controls; a Genlyte Company.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

C. Electromechanical-Dial Time Switches: Type complying with UL 917.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
2. Lithonia Lighting; Acuity Lighting Group, Inc.
3. Novitas, Inc.
4. TORK.
5. Watt Stopper (The).

2.3 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

4. Mounting:

- a. Sensor: Suitable for mounting in any position on a standard outlet box.
- b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
- c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.4 OUTDOOR MOTION SENSORS (PIR)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Watt Stopper (The).

C. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as rain-tight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

3. Bypass Switch: Override the on function in case of sensor failure.

4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

D. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.5 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE.
5. TORK.

B. Description: Electrically operated and mechanically held, combination type with non-fusible switch complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. All conductors shall be installed in an enclosed by a metal raceway.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 23

26 11 00

FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of Division 26 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.2 SECTION INCLUDES

A. Fireproof fire stopping materials.

1.3 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

A. Fireproof fire stopping materials.

B. Provide U.L. category and file numbers of products.

1.4 QUALITY ASSURANCE: COMPLY WITH THE FOLLOWING.

A. ASTM E814 (UL 1479) - Test Method of Fire Tests of Through-Penetration Fire stops.

B. NEC 300-21 and NEC 800-52(b).

C. Conform to applicable code for fire resistance ratings and surface burning characteristics.

D. Provide certificate of compliance from authority having jurisdiction indicating approval of combustibility.

1.5 SEQUENCING

A. Sequence work to permit fire stopping materials to be installed after adjacent and surrounding work is complete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Flame-Safe FS500, FST600, FS900, FST900, or FSP1000.

B. Dow Corning 306548 Silicone RTV Foam.

C. 3M Fire Barrier Penetration Sealing Systems.

D. PENSIL 851, General Electric Company.

2.2 PERFORMANCE REQUIREMENTS

A. The requirements of this section shall be provided in addition to the requirements of Division 7.

B. Maintain required classification, fire, acoustic, and vapor barrier ratings for electrical installations penetrating walls, ceilings, and floors per ASTM E814 (UL 1479), NEC 300-21 and NEC 800-52(b).

1. Penetrations of classified area walls, ceiling and floors shall be sealed with the same material to maintain the integrity of area classification.
2. Penetrations of fire-rated walls, ceilings, and floors shall be sealed with a UL listed Through-Penetrations Fire-Stop System.
3. Penetrations of non-fire-rated walls, ceilings, and floors shall be filled and finished using the same finish material as the wall, ceiling, or floor.
4. Outlet box and lighting fixture installation in fire-rated walls, ceilings, and floors shall be in accordance with the UL Fire Resistance Directory.

C. Fire safety system shall not require de-rating the ampacity of electrical conductors.

D. Where mastic is used to seal the surface of the fire stop, the mastic shall be non-hardening.

E. Fire safety material shall not contract to allow transmission of smoke or water prior to exposure of a fire condition.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that openings are ready to receive the work of this section.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of fire stopping material.

B. Remove incompatible materials which affect bond.

3.3 APPLICATION

A. Apply primer and materials in accordance with manufacturer's instructions.

B. Apply fire stopping material in sufficient thickness to achieve rating to uniform density and texture.

C. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit, and other items requiring fire stopping.

D. Sleeves shall be of suitable length to accommodate fire stopping system used. Where conduit passes through a sleeve, the clearance around the conduit shall not be less than 1/2".

3.4 CLEANING

A. Clean adjacent surfaces of fire stopping materials.

3.5 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 26 11 00

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26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Harmonics Mitigating (Canceling) Transformers as indicated on Drawings:
 - a. Delta-to-ZigZag 0-degree phase shift secondary.
 - b. Wye-to-ZigZag 30-degree phase shift secondary.

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Qualification Data: For testing agency.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

- D. Harmonics Canceling Transformers: NEMA ST-1, TP-1, TP-2 and IEEE-519-1992 compliance.
- E. Comply with United States Department of Energy (DOE), United States Code (USC) and Code of Federal Regulations (CFR)
 - 1. 42 USC - Energy Conservation Program for Consumer Products Other Than Automobiles
 - 2. 10 CFR 431 – Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart K – Distribution Transformers
 - 3. Appendix A to Subpart K of 10 CFR part 431 - Uniform Test Method for Measuring the Energy Consumption of Distribution Transformers

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General Purpose Dry-Type: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D / Schneider Electric
 - 2. Siemens
 - 1. Eaton / Cutler Hammer
- B. General Purpose Dry-Type: Subject to compliance with requirements, provide products by one of the following:
 - 1. Powersmiths T1000-30H
 - 2. Power Quality International
 - 3. Mirus
 - 3.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper, unless indicated otherwise in Drawings.

- 3. Core and coil designs shall be low loss type with minimum efficiencies per NEMA TP1 and 10 CFR §431.196(a)(2) (DOE 2016 requirements) when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP2 and 10 CFR §431.193.
- D. Enclosures: NEMA 2 or 3R rating as required, unless otherwise indicated on Drawings.
 - 1. Provide hinged doors with infrared scanning window.
 - 2. Provide surge protection device (SPD).
 - 3. Provide compression lug kit for all terminations.
- E. Efficiencies:

Single phase		Three Phase	
kVA	Efficiency	kVA	Efficiency
15	97.7%	15	97.89%
25	98.0%	30	98.23%
37.5	98.2%	45	98.40%
50	98.3%	75	98.60%
75	98.5%	112.5	98.74%
100	98.6%	150	98.83%
167	98.7%	225	98.94%
250	98.8%	300	99.02%
333	98.9%	500	99.14%
		750	99.23%
		1000	99.28%

2.3 HARMONIC MITIGATING TRANSFORMERS

- A. Single Output (Secondary):
 - 1. DZ0 – Delta Primary, Zig-Zag Secondary, 0° phase shift.
 - 2. YZ30 – Wye Primary (ungrounded neutral), Zig-Zag Secondary, 30° phase shift.
- B. Insulation and Varnish systems: 220 deg. C. Class R, Epoxy polyester impregnation, 130°C Temperature Rise in 40°C Ambient.
- C. All terminals. Including those for changing taps, must be readily accessible. Windings shall be continuous with terminations brazed or welded. 10KV BIL.
- D. Compatible with all types of linear and non-linear current and future loads.
- E. Impedance: Between 3.0% and 5.0% at rated KVA.
- F. Zero sequence Impedance/reactance less than 0.95% and 0.3% respectively.
- G. Zero sequence currents not coupled into primary windings.
- H. Voltage Taps: Two (2) 2.5% above and four (4) 2.5% below nominal primary voltage.
- I. Provide dual electrostatic shield.

2.4 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

- B. Cores: One (1) leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Taps for Transformers Smaller than 3 kVA: None.
- E. Taps for Transformers 7.5 to 10 kVA: Two (2) 5 percent taps below rated voltage.
- F. Taps for Transformers 15 kVA and Larger: Two (2) 2.5 percent taps above and four (4) 2.5 percent taps below normal full capacity.
- G. Insulation Class: Class R (220 deg C), UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
- I. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- J. Wall Brackets: Manufacturer's standard brackets.
- K. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- L. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
- M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested, shall be in according to IEEE C57.12.91.

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- C. Testing will also include recording of the voltages on the primary and secondary including the Impedance used.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions. Working Clearance shall not be less than 4 feet in front of the front cover. Inform engineer if there is a potential clearance problem prior to rough-in.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer. Install a ground copper bar for all grounding connections. Single lug grounding is not permissible.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Grounding electrode conductor will be installed in conduit and connected with Blackburn clamps. A connection will be made to building steel and a new driven copper ground rod.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer. If ceiling mounting is utilized, a letter shall be obtained and approved by a structural engineer.
 - 1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.
- C. Install ALL floor mounted transformers as indicated on 6" housekeeping pads 4" inches larger than transformer, complying with manufacturer's written instructions, applicable requirements of NEC, NESC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements. Provide NEC working clearance in front of transformers assuming they will require examination while energized.
- D. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- E. Install floor mounted units with bolts to equipment pad with neoprene/cork vibration mounts between transformer and pad. Comply with manufacturer's indicated installation method, if any.
- F. Connect transformer units to electrical wiring system with flexible metal conduit or liquid tight flexible metal conduit. Comply with the requirements of other Division 16 sections.
- G. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where

manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL STD 486A. Record torques on all terminations.

- H. Back off shipping bolts on internal vibration isolators.
- I. Provide complementary 0° and 30° phase-shift in as equal capacities for each bus as possible to maximize harmonic mitigation.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems." Install a ground copper bar to where all connections are made. Do not use single lugs. The GEC conductor shall be installed directly to XO terminal. Use grounding bushing.
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Carefully remove the wire insulation without damaging the copper wire strands and check all connections are to be tight.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Infrared (Baseline) Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.
- G. Provide equipment grounding connections for power/distribution transformers, sizes per NEC. Tighten connections to comply with tightening torques specified in UL STD 486A to assure permanent and effective grounding.
- H. Transformer Testing

1. Certified Test Reports in accordance with TP-1-2002 and TP-2.
2. Open Circuit transformer tests, for calculating percent zero-sequence impedances and reactance as follows:
 - a. With the transformer's primary terminals open-circuited, make a low impedance connection between secondary Terminals X1, X2 and X3.
 - b. Connect a variable 60HZ power source between Secondary Terminals X1, X2, X3 and X0, which includes precision revenue class voltage and current measurement instrumentation.
 - c. Increase 60HZ voltage across Terminals X1, X2, X3 and Terminal X0 until $>2/3$ full-scale readings are obtained on the voltage and current meters. In no case can the current reading exceed the full load rating of the winding under test. The values may be lower since impedance and reactance are linear.
 - d. Calculate impedance in Ohms based on the measured voltage and current values.
 - e. Based on the measured voltage, as a percentage of the rated voltage of the windings, calculate percent zero-sequence impedance and reactance.
3. Closed Circuit Transformer Tests, for calculating transformer core and copper losses as follows:
 - a. In accordance with e-Rated Transformer Corporation Standard Publications VAD1-2003 and VAD2- 2003.
 - b. Measure Primary and Secondary voltage and current differences simultaneously, using 'revenue class' instrumentation and calculate excitation or no-load losses and impedances/load losses.
 - c. Submit such reports as part of shop drawings submittals for each size typical transformers, based on tests done within a year or less time.
 - d. Submit such reports for all the transformers for the project, prior to shipment.
4. Design, manufacturing and testing of these transformers, in compliance with most current NEMA, IEEE and Industry standards and practices.
5. Transformer Loss Calculations based on primary and secondary voltage and current differences measured simultaneously.

3.5 PROTECTION

- A. Physically protect transformers against damage. All field-repairs to be performed by and approved by factory-authorized service representative at no added cost to Owner:
 1. Touch-up scratches and removed paint with original factory paint.
 2. Replace dented plates and panels.
 3. Replace scratched, discolored, or otherwise damaged nameplate labels.

3.6 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results. All test reports on transformers shall be compile to one database and this must be submitted to the Owner.
- A. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- B. Output Settings Report: Prepare a written report recording output voltage and tap settings.

3.7 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

A. SPD: Surge protective device (suppressor).

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and over-current protective device, surge suppression Protective device (SPD), accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

A. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and over-current protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual over-current protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of over-current protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of over-current protective device.
9. Fault current rating, brazing and bus rating

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting over-current protective devices.
2. Time-current curves, including selectable ranges for each type of over-current protective device that allows adjustments.

1.5 QUALITY ASSURANCE

B. Source Limitations: Obtain panelboards, over-current protective devices, components, and accessories from single source from single manufacturer.

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than two weeks days in advance of proposed interruption of electric service.
2. Comply with NFPA 70E.

1.8 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock. All keys shall be turn-in to Owner.

2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets, as indicated on Drawings:

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

b. Outdoor Locations: NEMA 250, Type 3R.

c. Wash-Down Areas: NEMA 250, Type 4X stainless steel.

d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 5.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Door in door Hinges: For ease of access to branch circuit wiring.

5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

7. Finishes:
 8. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - a. Back Boxes: Same finish as panels and trim.
 9. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn Copper, 98 percent conductivity.
 2. Coating: Electroplated with Tin to a minimum thickness of 30 micron.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 6. Split Bus: Vertical buses divided into individual vertical sections.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Sub-feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and over-current protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series-connected ratings are not acceptable.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D / Schneider Electric
 2. Cutler-Hammer / Eaton
 3. General Electric / ABB
 4. Siemens
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Over-current Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Branch Over-current Protective Devices: Circuit Breaker.

H. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D / Schneider Electric
2. Cutler-Hammer / Eaton
3. General Electric / ABB
4. Siemens

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Over-current Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series-connected ratings are not acceptable.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for over-current protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box. Mount surface panelboards on 1-5/8 x 1-5/8 Unistrut not on wall surface.
- G. Install over-current protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade. All empty conduits shall be enclosed or sealed.
- J. All conduits, junction boxes, pull boxes and entering and leaving shall be marked or label with circuit numbers.

K. Conductors inside the panelboards shall be install neat, order and workmanlike manner. Comply and refer to NEC Article 312.

L. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

A. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection report, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

- A. Set field-adjustable circuit-breaker trip ranges as indicated.

- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

- B. Physically protect panelboards against damage. All field-repairs to be performed by and approved by factory-authorized service representative at no added cost to Owner:
 - 1. Touch-up scratches and removed paint with original factory paint.
 - 1. Replace dented plates and panels.
 - 2. Repair or replace damaged or non-functional devices.
 - 3. Replace scratched, discolored, or otherwise damaged nameplate or device identification labels.

3.1 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

- B. Clean the outside and inside the switchboards free from dust.

END OF SECTION 26 24 16

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ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes equipment for electricity metering by Owner.

1.3 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.

2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

C. Field quality-control reports.

D. Operation and Maintenance Data. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.

2. Software licenses.

3. Software service agreement.

4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two weeks in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D / Schneider Electric
2. E-Mon
3. National Meter Industries
4. General Electric / ABB
5. Eaton

B. General Requirements for Owner's Meters:

1. Comply with UL 1244.
2. Meters used for billing shall have an accuracy of 1.0 percent of reading, complying with requirements in ANSI C12.20.
3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
4. Identification: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
 - a. Type: Split and solid core.
7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated,

demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

C. Kilowatt-hour Meter: Electronic three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25-inch-high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kilowatt-hours.

D. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25-inch-high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Division 26 Section "Control-Voltage Electrical Power Cables."

F. Software: PC-based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
 2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 1. Connect a load of known kilowatt rating, 15 kW minimum, to a circuit supplied by metered feeder.

2. Turn off circuits supplied by metered feeder and secure them in off condition.
 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
- C. Electricity metering will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 13

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WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Hospital Grade
5. Wall-box motion sensors.
6. Isolated-ground receptacles.
7. Snap switches and wall-box dimmers.
8. Wall-switch and exterior occupancy sensors.
9. Communications outlets.
10. Pendant cord-connector devices.
11. Cord and plug sets.
12. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. SPD: Surge suppressor protective device.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configuration.

1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Service/Power Poles: One for every 10, but no less than one.

2. Floor Service Outlet Assemblies: One for every 10 but no less than one.

3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

4. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Pass & Seymour/LeGrand

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pass & Seymour/LeGrand ; 5381 (single), 5352 (duplex).

b. Hubbell; HBL5351 (single), CR5352 (duplex).

c. Leviton; 5891 (single), 5352 (duplex).

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pass & Seymour; 63H

- b. Hubbell; HBL8300SG.
- c. Leviton; 8300-SGG.

2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; 2084.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Receptacles: Comply with NEMA WD 1, NEMA WD 6 configuration and ratings as indicated on Drawings, and UL 498.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand
 - b. Hubbell
 - c. Leviton

B. Isolated-Ground, Single Receptacles:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell
 - b. Leviton
 - c. Pass & Seymour/Legrand

2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

- 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
- 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

- 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
- 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

C. Pilot Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; PS20AC1-PLR for 120 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; PS20AC1-L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; 1251.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand; 1251L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: By same manufacturer of other devices to match dimming technology of connected light fixtures.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

2.9 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pass & Seymour/Legrand
 - b. Hubbell
 - c. Leviton
 - d. Watt Stopper

2. Description: Dual technology Passive-infrared type/Ultrasonic, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

B. Long-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Hubbell; ATD1600WRP.
- b. Leviton; ODW12-MRW.
- c. Watt Stopper (The); DT-200.
- d. Pass & Seymour/Legrand

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

C. Wide-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Hubbell; ATP120HBRP.
- b. Leviton; ODWHB-IRW.
- c. Pass & Seymour; HS1001.
- d. Watt Stopper (The); CX-100-3.

2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

D. Exterior Occupancy Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Leviton; PS200-10.
- b. Watt Stopper (The); EW-100-120.
- c. Pass & Seymour/Legrand

2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.10 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; 3560-6.
- b. Leviton; 40649.

2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; 3562.
- b. Leviton; 40595.

2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.11 WALL PLATES

A. Single and combination types to be 302/304 stainless steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.12 FLOOR SERVICE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; System One.
- B. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- C. Compartments: Barrier separates power from voice and data communication cabling.
- D. Service Plate: Rectangular, solid brass, coordinate finish with Architect prior to ordering.
- E. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
- F. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.13 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; System One.
- B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/fire-stop unit and detachable matching floor service outlet assembly.
1. Service Outlet Assembly: Pedestal type with services indicated.
 2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 4. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.
 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.14 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: Minimum No. 12 AWG.

2.15 SERVICE POLES

- A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
1. Poles: Nominal 2.5-inch square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 3. Finishes: Manufacturer's standard painted finish and trim combination.
 4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.

5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
6. Voice and Data Communication Outlets: Blank insert with bushed cable opening.

2.16 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: Ivory, or as selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. TVSS Devices: Blue.
 4. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes. Cut holes need not to be more than 1/8" inch in all sides of the box.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Boxes and conduit shall be rigidly supported to the wall. Do not use spacer type supports.
 5. Install wiring devices after all wall preparation, including painting, is complete.
 6. Do not use extension ring in any applications.
- C. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300.14, without pigtails. Multiple duplex receptacles shall be use pigtail and use the screw terminals to terminate the wire not the back of the receptacle outlet.
 4. Conductors shall be identified with circuit number at the box.
 5. Existing Conductors:
 - Cut back and pigtail or replace all damaged conductors.
 - a. Straighten conductors that remain and remove corrosion and foreign matter.
 - b. Pigtailing existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 5. Use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 20-A circuits, splice No. 12 AWG pigtailed for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
2. Receptacles: Label or mark the cover with panel and circuit number back and front cover.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

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FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches, fuse-holders, and panelboards.
3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
4. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

- A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

- A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuse-holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: Class L, fast acting.
 - 2. Feeders: Class L, fast acting
 - 3. Motor Branch Circuits: Class RK1 and Class RK5, time delay.
 - 4. Other Branch Circuits: Class J, fast acting.
 - 5. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuse-holders and sockets. Ensure that adapters are irremovable once installed.
- C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

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ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers.
6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual over-current protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of over-current protective device; include selectable ranges for each type of over-current protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of over-current protective device; include selectable ranges for each type of over-current protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, over-current protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D / Schneider Electric
2. Cutler-Hammer / Eaton
3. General Electric / ABB
4. Siemens

B. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hook stick Handle: Allows use of a hook stick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.
9. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D / Schneider Electric
2. Cutler-Hammer / Eaton
3. General Electric / ABB
4. Siemens

B. Type HD, Heavy Duty, Single Throw, 240, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 240, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 240, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hook-stick Handle: Allows use of a hook-stick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D / Schneider Electric
2. Cutler-Hammer / Eaton
3. General Electric / ABB
4. Siemens

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I²t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
7. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Electrical Operator: Provide remote control for on, off, and reset operations.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, SS-304.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X SS-304.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

- a. **Initial Infrared Scanning:** After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
- b. **Follow-up Infrared Scanning:** Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
- c. **Instruments and Equipment:** Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection report, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

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ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Reduced-voltage magnetic.
4. Reduced-voltage solid state.
5. Multi-speed.

B. Related Section:

1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200HP.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Over-current protective device.
- G. SCR: Silicon-controlled rectifier.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Nameplate legends.

- d. Short-circuit current rating of integrated unit.
 - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
2. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for enclosed controllers and installed components.
 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.
3. Indicating Lights: 2 of each type and color installed.
4. Auxiliary Contacts: Furnish 1 spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish 3 spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Square D.
 - b. GE.
 - c. Cutler-Hammer.
 - d. Asco
 2. Configuration: Non-Reversing.
 3. Surface mounting.
 4. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Square D.
 - b. GE.
 - c. Cutler-Hammer.
 - d. Asco
 2. Configuration: Non-reversing.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button.
 4. Surface mounting.
 5. Not all manufacturers offer a green pilot light; pilot lights are not available in hazardous and some cast-type enclosures.
 6. Red pilot light.
- D. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Square D.
 - b. GE.
 - c. Cutler-Hammer.
 - d. Asco
 2. Configuration: Non-reversing.
 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 4. Control Circuits: 120 V ac; obtained from integral CPT, with primary and secondary fuses and sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 5. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - e. Analog communication module.
 6. External overload reset push button.
- E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Square D / Schneider Electric
 - b. Cutler-Hammer / Eaton
 - c. General Electric / ABB
 - d. Siemens
 2. MCP Disconnecting Means:

- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.C. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
3. MCCB Disconnecting Means:
- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. N.C. alarm contact that operates only when MCCB has tripped.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1.
 2. Outdoor Locations: Type 3R.
 3. Kitchen and Wash-Down Areas: Type 4X, stainless steel.
 4. Other Wet or Damp Indoor Locations: Type 4X-ss.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
 6. Hazardous Areas Indicated on Drawings: Type 9.

2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
1. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty, oil-tight type.
- B. N.C., N.O. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Under-voltage and Over-voltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable under-voltage, over-voltage, and time-delay settings.
- E. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

- G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- H. Cover gaskets for Type 1 enclosures.
- I. Terminals for connecting power factor correction capacitors to the load side of overload relays.
- J. Spare control wiring terminal blocks, quantity as indicated; unwired.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible-switch enclosed controller.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- F. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Install power factor correction capacitors. Connect to the line/load side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures. Use 'Panduit' where possible.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermo graphic) scan tests and inspections and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

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ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
1. Gas engine.
 2. Unit-mounted cooling system.
 3. Unit-mounted and Remote-mounting control and monitoring.
 4. Performance requirements for sensitive loads.
 5. Outdoor enclosure.
- B. Related Sections include the following:
1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

- C. Retain abbreviation and terms that remain after this Section has been edited.
- D. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- E. LP: Liquid petroleum.

1.4 SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
1. Thermal damage curve for generator.
 2. Time-current characteristic curves for generator protective device.
- B. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 4. Wiring Diagrams: Power, signal, and control wiring.
- D. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Qualification Data: For manufacturer.
- F. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 5. Report of sound generation.
 6. Report of exhaust emissions showing compliance with applicable regulations.
 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- I. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with ASME B15.1.
- G. Comply with NFPA 37.
- H. Comply with NFPA 70.
- I. Comply with NFPA 99.
- J. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- K. Comply with UL 2200.
- L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 5 to 40 deg C.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 1000 feet.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Division 07 Section "Roof Accessories."

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
Warranty Period: 5 years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, are limited to the following:
 - 1. Cummins
 - 2. Caterpillar
 - 3. Kohler
 - 4. Aksa
 - 5. Taylor

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

- C. Capacities and Characteristics:
1. Power Output Ratings: Nominal ratings as indicated.
 2. Output Connections: Three-phase, four wire.
 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
 4. Generators shall be designed with a 72 hour running capacity.
- D. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 8. Start Time: Comply with NFPA 110, Type 10, system requirements.
- E. Generator-Set Performance for Sensitive Loads:
1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
 2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
 3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
 4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
 5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
 7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not

less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Depending on NFPA 110 class and local codes, LP-gas standby may not be required for natural gas-fueled systems. Verify requirements with authorities having jurisdiction.
- B. Fuel: Natural gas with automatic LP-gas standby.
- C. Rated Engine Speed: 1800 rpm.
- D. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- E. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- F. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
 3. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:
 - a. Carburetor.
 - b. Secondary Gas Regulators: One for each fuel type.
 - c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
 - d. Flexible Fuel Connectors: One for each fuel source.
- G. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- H. Governor: Adjustable isochronous, with speed sensing.
- I. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

- J. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
 1. Configuration: Vertical air discharge.
 2. Radiator Core Tubes: Aluminum.
 3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 5. Fan: Driven by totally enclosed electric motor with sealed bearings.
 6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

- K. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 1. Minimum sound attenuation of 25 dB at 500 Hz.
 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

- L. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

- M. Select first option in paragraph below for smaller engine-generator sets. Retain second option for units 175 kW and larger.

- N. Starting System: 24-V electric, with negative ground.
 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

- a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
- b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
- c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 CONTROL AND MONITORING

- A. This Article specifies the subsystem that monitors, protects, and controls the engine generator. See Editing Instruction No. 8 in the Evaluations.
- B. Retain first paragraph below for automatically starting systems; retain second paragraph for manually starting systems.
- C. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- D. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- E. Retain one of three paragraphs below to describe control and monitoring unit configuration. Coordinate retained paragraph with Drawings. Retain first paragraph unless special requirements justify significant extra cost of one of the other two configurations. See Evaluations.
- F. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- G. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.
- H. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel.

Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:

1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
 2. Switchboard Construction: Freestanding unit complying with Division 26 Section "Switchboards."
 3. Switchgear Construction: Freestanding unit complying with Division 26 Section "Low-Voltage Switchgear."
 4. Current and Potential Transformers: Instrument accuracy class.
 5. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 - AC voltmeter.
 6. AC ammeter.
 7. AC frequency meter.
 8. DC voltmeter (alternator battery charging).
 9. Engine-coolant temperature gage.
 10. Engine lubricating-oil pressure gage.
 11. Running-time meter.
 12. Ammeter-voltmeter, phase-selector switch(es).
 13. Generator-voltage adjusting rheostat.
 14. Fuel tank derangement alarm.
 15. Fuel tank high-level shutdown of fuel supply alarm.
 16. Generator overload.
- I. Indicating and Protective Devices and Controls:
1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Coordinate five subparagraphs below with Drawings. See Evaluations for typical local and remote alarm indications and shutdowns.
 11. Start-stop switch.
 12. Overspeed shutdown device.
 13. Coolant high-temperature shutdown device.
 14. Coolant low-level shutdown device.
 15. Oil low-pressure shutdown device.
 16. Two subparagraphs below are optional devices.
 17. Fuel tank derangement alarm.
 18. Fuel tank high-level shutdown of fuel supply alarm.
 19. Generator overload.
- J. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- K. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

- L. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
 - 1. Overcrank shutdown.
 - 2. Coolant low-temperature alarm.
 - 3. Control switch not in auto position.
 - 4. Battery-charger malfunction alarm.
 - 5. Battery low-voltage alarm.

- M. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
 - 1. Engine high-temperature shutdown.
 - 2. Lube-oil, low-pressure shutdown.
 - 3. Overspeed shutdown.
 - 4. Remote emergency-stop shutdown.
 - 5. Engine high-temperature pre-alarm.
 - 6. Lube-oil, low-pressure pre-alarm.
 - 7. Fuel tank, low-fuel level.
 - 8. Low coolant level.

- N. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

- O. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.
 - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.

- B. Generator Disconnect Switch: Molded-case type, 100 percent rated.
 - 1. Rating: Matched to generator output rating.
 - 2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

- C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
 - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.

2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip proof.
- G. Delete first paragraph below if instrument transformers are housed in control and power panel.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Level II sound resistant, Vandal-resistant, weatherproof steel housing, wind resistant up to 139 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:
 1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.

3. Space Heater: Thermostatically controlled and sized to prevent condensation.
 4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 5. Hinged Doors: With padlocking provisions.
 6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
 7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
 8. Muffler Location: Within enclosure.
- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- D. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
1. AC lighting system and connection point for operation when remote source is available.
 2. DC lighting system for operation when remote source and generator are both unavailable.
- E. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.8 MOTORS

- A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.9 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Material: Standard neoprene.
- B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Full load run.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Transient and steady-state governing.
 - 6. Single-step load pickup.
 - 7. Safety shutdown.
 - 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 - 9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel

pipng materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- F. The location of the emergency power generator shall be away from fresh air intakes and other areas where fumes may enter the building.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Connect fuel piping to engines with a gate valve and union and flexible connector.
 1. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-Gas Piping."
 2. LP-gas piping, valves, and specialties for gas piping are specified in Division 23 Section "Facility Liquefied-Petroleum Gas Piping."
- E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- G. The following equipment shall be connected to the generator: fire alarm system, PA system, security system, kitchen freezers and coolers, gym light fixtures, energy management system, server room, A/C for server room, select administrative office receptacles, elevators, auditorium egress lighting, emergency lights, and select light fixtures. One 110v double duplex receptacle and one overhead light in each mechanical room, electrical room, and data closet shall be connected to the generator

3.4 IDENTIFICATION

- A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

- D. Perform tests and inspections and prepare test reports.
- E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- F. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - 4. Verify that measurements are within manufacturer's specifications.
 - 5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 - 7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 - 8. Exhaust Emissions Test: Comply with applicable government test criteria.
 - 9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
 - 10. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 - 11. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- G. Coordinate tests with tests for transfer switches and run them concurrently.
- H. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- I. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- J. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- K. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- L. Remove and replace malfunctioning units and retest as specified above.
- M. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- N. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- O. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 32 13

26 36 00

TRANSFER SWITCHES

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
1. Automatic transfer switches.
 2. Bypass/isolation switches.
 3. Remote annunciation systems.
- B. Related Sections include the following:
1. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.
 2. Division 21 Section "Electric-Drive, Vertical-Turbine Fire Pumps" for automatic transfer switches for fire pumps.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Coordination Drawings: Provide coordination drawings as described in 26 05 00 paragraph 1.03(C).
- C. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 2. Retain paragraph and subparagraphs below if required by seismic criteria applicable to Project. Coordinate with Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For manufacturer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Features and operating sequences, both automatic and manual.
 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA ICS 1.
- F. Comply with NFPA 70.
- G. Comply with NFPA 99.
- H. Comply with NFPA 110.
- I. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Transfer Switches Using Molded-Case Switches or Circuit Breakers:

- a. ASCO
- b. Caterpillar
- c. Cummins Power Generation
- d. Kohler

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Where four-pole switches are indicated, provide overlapping neutral contacts.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- J. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
- K. Battery Charger: For generator starting batteries.
 - 1. Float type rated 10 A.
 - 2. Ammeter to display charging current.
 - 3. Fused ac inputs and dc outputs.
- L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

- M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- G. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- H. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:
 - 1. Fully automatic make-before-break operation.
 - 2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
 - 3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
 - a. Initiation occurs without active control of generator.
 - b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
 - 4. Failure of power source serving load initiates automatic break-before-make transfer.
- I. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

- J. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- K. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- L. Automatic Transfer-Switch Features:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 5. Test Switch: Simulate normal-source failure.
 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
 12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
 13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

- a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
- b. Push-button programming control with digital display of settings.
- c. Integral battery operation of time switch when normal control power is not available.

2.4 REMOTE ANNUNCIATOR SYSTEM

- A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 2. Switch position.
 3. Switch in test mode.
 4. Failure of communication link.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
 1. Indicating Lights: Grouped for each transfer switch monitored.
 2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
 3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
 4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- D. Identify components according to Division 26 Section "Identification for Electrical Systems."
- E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer.

Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
 - 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - Check for electrical continuity of circuits and for short circuits.
 - a. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - b. Verify that manual transfer warnings are properly placed.
 - c. Perform manual transfer operation.
 - 5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 - 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - Verify grounding connections and locations and ratings of sensors.

- D. Testing Agency's Tests and Inspections:
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - a. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 3. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 4. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
Verify grounding connections and locations and ratings of sensors.
- E. Coordinate tests with tests of generator and run them concurrently.
- F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- G. Remove and replace malfunctioning units and retest as specified above.
- H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes lightning protection for structures.

1.3 SUBMITTALS

- A. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- B. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- C. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- D. Field quality-control reports.
- E. The qualified installer must provide a system which measures no more than 2 ohms resistance.
- F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods.
 - 2. Ground loop conductor.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. UL Master Label.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
 - 1. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class I copper.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Advanced Lightning Technology
 - b. Bonded Lightning Protection Systems
 - c. Thompson Lightning Protection
 - 2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
 - 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.
- C. Main and Bonding Conductors: #2/0 Copper
- D. Ground Loop Conductor: #2/0 Copper
 - 1. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

- F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- G. Ground Loop: Install ground-level, potential equalization #2/0 copper conductor and extend around the perimeter of structure.
 - 1. Bury ground ring not less than 24 inches from building foundation.
 - 2. Bond ground terminals to the ground loop.
 - 3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
- H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.
- D. Provide and record and submit the testing reports once installation has been completed and certified.

END OF SECTION 26 41 13

26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes field-mounted SPD's for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Sections:

1. Division 26 Section "Switchboards" for factory-installed SPD's.
2. Division 26 Section "Panelboards" for factory-installed SPD's.
3. Division 26 Section "Wiring Devices" for devices with integral SPD's.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protective Device(s), both singular and plural.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
- B. Qualification Data: For qualified testing agency- (NRTL) National Recognized Testing Laboratory
- C. Product Certificates: For SPD devices, from manufacturer.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA or the equipment manufacturer to supervise on-site testing.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- D. Comply with UL 1283 and UL 1449 (current edition).
- E. The SPD installation complies with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than four days in advance of proposed electrical service interruptions.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.
- B. Coordinate SPD devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five (5) years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Where equipment design uses replaceable protection modules: One (1) of each size and type installed.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D.
 - 2. GE.
 - 3. Eaton/ Cutler-Hammer.
 - 4. Liebert
 - 5. Current Technology Inc.; Danaher Power Solutions.
 - 6. Leviton
- B. Surge Protection Devices:
 - 1. Comply with UL 1449 (current edition).
 - 2. Modular design.
 - 3. Fuses, rated at 200-kA interrupting capacity.
 - 4. Fabrication using bolted compression lugs for internal wiring.

5. Integral disconnect switch or circuit breaker.
6. Redundant suppression circuits.
7. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
9. LED indicator lights for power and protection status.
10. Audible alarm, with silencing switch, to indicate when protection has failed.
11. Form-C contacts rated at 1 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
12. Six-digit transient-event counter set to totalize transient surges.

C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
2. Line to Ground: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

2.2 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D.
2. GE.
3. Eaton/ Cutler Hammer.
4. Advanced Protection Technologies Inc. (APT).
5. Current Technology Inc.

B. Surge Protection Devices:

1. Non-modular.
2. LED indicator lights for power and protection status.
3. Audible alarm, with silencing switch, to indicate when protection has failed.
4. Form-C contacts rated at 1 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
2. Line to Ground: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

2.3 ENCLOSURES

- A. Indoor Enclosures: NEMA 250 Type 1.
- B. Outdoor Enclosures: NEMA 250 Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground at the SPD. Ground only at NEC required locations.
 1. Provide manufacturer's approved circuit breaker as applicable as a dedicated disconnecting means for SPD unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 3. Complete startup checks according to manufacturer's written instructions.

- C. SPD device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Do not energize or connect service entrance equipment, panelboards, control terminals or data terminals to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 26 43 13

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INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures and drivers.
2. Emergency lighting units.
3. Exit signs LED lighted
4. Lighting fixture supports.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multiple lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
3. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

C. Submittals:

1. Provide cut-sheets and summary all types of fixtures for review.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. RCR: Room cavity ratio.

G. LED Light Emitted Diode

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast.

4. Energy-efficiency data.
5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
7. Life, output, and energy-efficiency data for lamps.
8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 1. Wiring Diagrams: Power and control wiring.
- C. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
 1. Lamps: Specified units installed.
 2. Accessories: Cords and plugs.
- D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

E. Mockups: Provide interior lighting fixtures for room or module mock-ups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 2. Warranty Period for Emergency Fluorescent Ballast Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
 2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.
- C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: Two (2) year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Battery and Charger Data: One for each emergency lighting unit.
 4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

C. Luminaires, Acceptable Manufacturers:

- 1.
2. Philips
3. Hubbell
4. Kenall
5. Lithonia
6. Cooper

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

A. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metalized Film: 90 percent.

G. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.

b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures, indicated to require a filter, with one filter per ballast.

I. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."

1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat Removal Units: Air path leads through lamp cavity.
3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 20 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.88 or higher.
7. Power Factor: 0.95 or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for T5 Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

D. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.

E. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

G. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
11. Ballast Case Temperature: 75 deg C, maximum.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect un-switched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 15 percent.
4. Transient Voltage Protection: IEEE C62.41, Category A or better.
5. Lamp Current Crest Factor: 1.5 or less.
6. Power Factor: .90 or higher.
7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
8. Protection: Class P thermal cutout.
9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 35 percent of rated lamp lumens.
 - c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.
 - a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.
 - b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

D. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant Re-strike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.

- a. Re-strike Range: 105- to 130-V ac.
- b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2. Minimum Starting Temperature: Minus 40 deg F.

3. Open-circuit operation shall not reduce average lamp life.

2.7 EXIT SIGNS LED LIGHTED

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.

2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

- a. Battery: Sealed, maintenance-free, nickel-cadmium type.
- b. Charger: Fully automatic, solid-state type with sealed transfer relay.
- c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
- e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
- g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

4. Master/Remote Sign Configurations:

- a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
- b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.8 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches

deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

7. Integral Time-Delay Relay: Holds unit on for fixed interval of 5 minutes when power is restored after an outage.

8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least four independent support rod or wire from BUILDING structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aim-able lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

A. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.3 CLEANING

- A. Clean the diffuser or lenses before installing to the fixture.

END OF SECTION 26 51 00

26 90 20

ELECTRICAL CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of Division 26 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.2 SECTION INCLUDES

- A. Cabinets.
- B. Relays/Contactors.
- C. Photo cells.
- D. Time clocks.
- E. Power supplies.
- F. Terminal blocks.
- G. Plastic wiring troughs.
- H. Miscellaneous.

1.3 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

- A. Shop Drawings: Provide complete point to point wiring diagrams inside low voltage panels and from panels to control/switching sources. Provide shop drawings indicating all conduit sizes and locations required for switching system.
- B. Product Data: Provide for each device specified. Indicate coil and contact ratings, dimensions, cabinets and accessory items.
- C. Provide category and UL file number for products.
- D. Warranties.
- E. Submittals for this section shall be signed by the subcontractor responsible for Division 13 controls, also.

PART 2 - PRODUCTS

2.1 CABINETS

A. Factory mount relays, time clocks, power supplies, terminal blocks, wiring troughs and accessories in a NEMA 1 cabinet conforming to Section 260533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS by a UL 508 listed manufacturer unless otherwise directed.

- B. Contactors/relays shall be individually identified with name tags. All wiring within cabinets shall be pre wired through plastic wiring troughs and brought to terminal blocks for field connections. Wires at terminal blocks and contactors/relays shall be identified by contactor/relay and pole number.
- C. Low voltage control wiring shall conform to Section 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600V wires and cables.
- D. Provide 1/4" minimum spacing between non-power limited wiring and power limited wiring.
- E. Cabinet and components shall be suitable for installation and operation in an unconditioned space.
- F. Relay cabinet power shall be 120 volts or as otherwise indicated.
- G. Cabinets shall be lockable, keyed alike. Furnish two (2) keys for each cabinet.
- H. Provide wire bending space, clearances, construction, etc. in accordance with NEC-312.

2.2 RELAYS/CONTACTORS

- A. Provide mechanically held SPST Class A150 contacts of required number, voltage, and current rating conforming to NEMA ICS 2 and UL 508 "industrial control equipment." Contacts shall be fully field convertible from N.O. to N.C.
 - 1. Magnetic Control Relay: Class A300.
 - 2. Time Delay Relay: Class A600.
- B. Control coil shall be Class 2 power limited with solid state control accessories as required.
- C. Line and low voltage terminals shall be screw type.
- D. Relays shall be ASCO 917 with 47, 48 or 49 Series control modules as required or equal by General Electric, Square D, Westinghouse/Cutler-Hammer, Siemens/ITE

2.3 PHOTO CELLS

- A. Photocell switch manufactured to NEMA ICS 2 and UL 773A "Non-industrial Photoelectric Switches for Lighting Control."
- B. Provide voltage, NEMA rating, contact rating and contact configuration as required.
- C. Sensitivity two (2) footcandles to 50 footcandles, adjustable.
- D. Provide photo cells manufactured by Intermatic, Dayton, Paragon or Tork.

2.4 TIME CLOCKS

- A. Provide 24 hour clock timer manufactured to NEMA ICS 2 and UL 917 "Clock Operated Switches" with two (2) astronomic time setting and 12 hour spring wound reserve power carry over.
- B. Manufacturers: Intermatic, Dayton, Paragon, Tork.

2.5 POWER SUPPLY

- A. Provide low voltage power supply in conformance with NEC Article 725 Class 2 and UL 1585 "Class 2 and Class 3 Transformers."
- B. Provide transformer size, primary, secondary fusing and accessories as required.
- C. Manufacturers: General Electric, Square D, Westinghouse, Dormeyer, White Rodgers.

2.6 TERMINAL BLOCKS

- A. Conform to NEMA ICS 4 and UL 486A "Wire Connectors and Soldering Lugs for use with Copper Conductors."
- B. Provide phenolic, channel mount, screw type terminals.
- C. Manufacturers: General Electric, Square D, Westinghouse, Cutler/Hammer, Buchanan, Allen-Bradley, Entrelec, Pass & Seymour/Legrand, Thomas and Betts, Marathon, IlSCO.
- D. Provide UL listed copper ground terminal.

2.7 PLASTIC WIRING TROUGHS

- A. Provide open slot vinyl wiring duct with snap on cover conforming to NEMA ICS 6 of width and height as required.
- B. Manufacturers: Gould Shawmut, Panduit, Rob Roy, Tyton, Electrovert, Pass & Seymour/Legrand, Leviton.

2.8 MISCELLANEOUS

- A. Provide miscellaneous items (diodes, solid state relays, logic chips, fuse holders, etc.) as required for a complete operating system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish all labor, materials, tools, equipment, and services for interface with HVAC controls, lighting controls, and other control systems as indicated and required by contract documents. Relays, conduit, wiring and accessories required shall be provided and installed.
- B. Completely coordinate with work of all other trades.
- C. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
- D. Mount control panels where indicated on drawings and provide proper NEC working clearance assuming panel will require examination while energized.
- E. Use manufacturer's recommended cable size for length of run and relays served.

F. Provide conduit and wire between control panels, power panels, relays and low voltage switches as required to achieve the sequence of operation indicated.

G. Inside relay cabinets, provide 1/4" minimum spacing between non-power limited wiring and power limited wiring. Otherwise, power limited wiring shall be in separate enclosures from non-power limited wiring.

3.2 DEMONSTRATION

A. Provide system demonstration under provisions of contract closeout.

END OF SECTION 26 90 20

26 95 00

FIELD ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of Division 26 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.2 SECTION INCLUDES

A. Testing by Installing Contractor

B. Testing by Independent Certified Testing Contractor

C. All testing shall be witness with the Owner, Commissioning Agent, Engineer or Architect.

1.3 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

A. Contractor shall submit experience and certified of testing firm and individuals who will be performing and evaluating tests before any tests are done.

B. Contractor shall submit in writing at least 24 hours in advance notification of the occurrence of any test described in this section.

C. Contractor shall record all test data and submit three (3) copies for review. In addition to the test data, each record shall include; date of test, ambient temperature, climate conditions, instruments used, names of test personnel and witnesses and identification of items tested.

D. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.4 QUALITY ASSURANCE: COMPLY WITH THE FOLLOWING.

A. All tests shall be done in accordance with all applicable codes and standards.

B. Qualifications of Testing Firm:

1. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

2. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

3. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, or be a Full Member company of the International Electrical Testing Association (IETA).

4. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DIVISION OF RESPONSIBILITY

A. All tests indicate in this specification section shall be done by the testing firm except the installing contractor shall be responsible for the following:

1. The contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
2. 120 Volt General Purpose Receptacles: All 120 volt general purpose receptacles shall be tested for correct connection using a Hubbell Catalog #5200 or equal receptacle tester.
3. 120 Volt Ground Fault Circuit, Interrupter (GFCI) Receptacles: All 120 volt GFCI receptacles shall be tested for correct connection and rating using Hubbell Catalog #GFT-2G with a range of 2 to 7 milliamps.
4. Enclosed (Disconnect) Switches: Subsequently to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.
5. Light Switching: Verify proper connection and operation of switches for lighting fixtures.
6. Lighting Contactors: Demonstrate proper operation of lighting contactors for all items indicated in Division 16.
7. Balancing Loads: After Substantial Completion, but not more than two months after Final Acceptance, conduct load-balancing measurements on panelboards and circuit changes as follows:
 - a. Perform measurements during period of normal working load as advised by the Owner.
 - b. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - c. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - d. Tolerance: Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

B. The Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported to the Owner/Engineer's representative replaced or repaired by the Contractor at no cost to the Owner, and retested.

E. An electrical system will not be accepted until tested in its entirety and results reported to the Owner.

3.2 TESTING FIRM

A. The testing firm shall test the following equipment as indicated in each section:

1. 600V Wire and Cables
2. Grounding and Bonding.
3. Dry Type Transformers.
4. Enclosed Motor Controllers
5. Motor Control Center
6. Panelboards
7. Switchboards/Switchgear

3.3 INFRARED BASELINE SCANNING

A. Provide scanning for Switchboards, Transformers, MCC's, Panelboards, Generator connection points, Copper Busses, Circuit Breakers, Terminations and Transfer Switches.

B. After Substantial Completion, but not more than two (2) months after Final Acceptance, perform an infrared IR scan in Section 26-95-00 Part 3, 3.2 of each panelboard, switchboard and pad mounted transformer. Remove fronts to make joints and connections accessible to a portable scanner.

C. Instrument: Use an approved infrared IR scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.

D. Record of Infrared IR Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 95 00

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SECTION 31 00 00 – EARTHWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and perform all excavation, backfill, fill and grading required to complete the work as shown on the Drawings and as specified herein. The work shall include, but not necessarily be limited to; excavation and backfill for electrical manholes, handholes, conduits, cables, raceways and ducts; embankment and grading; disposal of waste and surplus materials; and all related work such as sheeting, bracing, and dewatering.
- B. All excavation, trenching and related sheeting, bracing, etc, shall conform to the requirements of the Texas "State Safety Act" (CS/SB 2626) which incorporates, by reference, OSHA's excavation safety standards, 29 CFR 1926.650 Subpart P.
- C. Excavation, backfill, and compaction for structures and piping are included in other sections as listed below.

1.02 RELATED WORK

- A. Dewatering and Drainage is included in Section 312319 and 014127.
- B. Rock and Boulder Excavation is included in Section 312319.
- C. Structural Excavation Backfill and Compaction is included in Section 312319.
- D. Trenching and Backfilling for Utilities is included in Section 330528.

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 - Specification for Concrete Aggregates.
 - 2. ASTM D1557- Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,00 ft-lbf/ft (2,700kN-m/m)
 - 3. ASTM D1682- Standard Test Methods for Breaking Load and Elongation of Textile Fabrics.
 - 4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes.
 - 5. ASTM D4751- Standard Test Method for Determining the Apparent Opening Size of a Geotextile.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 PROTECTION

A. Sheeting and Bracing

1. Furnish, put in place and maintain such sheeting and bracing as may be required: by Federal, State and local safety requirements; to support the sides of excavations; to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction; and to protect adjacent structures from undermining or other damage. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete shall be used as backfill.
2. In order to protect adjacent structures, installation or removal of sheeting by vibratory or hammering methods shall not be allowed.
3. Construct the sheeting outside the neat lines of the foundation, unless indicated otherwise, to the extent deemed desirable for the method of operation. Sheeting shall be plumb and securely braced and tied in position. Sheeting and bracing shall be adequate to withstand all pressures to which the structure or trench will be subjected. Any movement or bulging which may occur shall be corrected to provide the necessary clearances and dimensions.
4. Where sheeting and bracing is required to support the sides of excavations for structures, engage a professional Engineer, registered in the State of Texas to design the sheeting and bracing. The sheeting and bracing installed shall be in conformity with the design and certification of this shall be provided by the professional Engineer. Submit P.E. Certification Form contained in Section 01 33 23 to show compliance with this requirement.
5. All sheeting and bracing not left in place shall be carefully removed in such manner as not to endanger the construction or other structures, utilities, or property. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, or otherwise as may be directed.
6. The right of the ENGINEER to order sheeting and bracing left in place shall not be construed as creating any obligation on his/her part to issue such orders and his/her failure to exercise his/her right to do so shall not relieve the CONTRACTOR from liability for damages to persons or property occurring from
or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the CONTRACTOR to leave in place sufficient sheeting and bracing to prevent any caving or moving of the ground.
7. No sheeting is to be withdrawn if driven below mid-diameter of any pipe and under no circumstances shall any sheeting be cut off at a level lower than 1-ft above the top of any pipe.

B. Pumping and Drainage

1. At all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fills, structures or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels. Engage a Geotechnical Engineer registered in the State of Texas to design the dewatering system in accordance with Section 312319 prior to commencing work.

2. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation. Well or sump installations shall be constructed with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.
3. Take all additional precautions to prevent uplift of any structure during construction.
4. Remove the dewatering equipment after the system is no longer required.

1.05 SOIL TESTING

- A. Previous to the general placement of the fill and during such placement, the ENGINEER may select areas within the limits of the fill for testing the degree of compaction obtained. Cooperate fully in obtaining the information desired.
- B. Payment for testing will be made by the OWNER CONTRACTOR as part of the project. If test results are unsatisfactory, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the ENGINEER, will be borne by the CONTRACTOR.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Select Common Soil and Structural Fill shall be as specified in Section 312323.
- B. Common soil shall be as specified in Section 312323.
- C. Crushed Stone
 1. Crushed stone shall conform to Texas Department of Transportation Class 57 stone gradation.
- D. Screened Gravel
 1. Screened gravel shall be used for pipe bedding as detailed and at other locations indicated on the Drawings.
 2. Screened gravel shall consist of hard, durable, rounded or subangular particles of proper size and gradation and shall be free from sand, loam, clay, excess fines and deleterious materials. The gravel shall be graded within the following limits:

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>
5/8-in	100
1/2-in	40 to 100
3/8-in	15 to 45
No.10	0 to 5

PART 3 EXECUTION

3.01 BACKFILLING - COMMON FILL

- A. Common Fill may be used as trench backfill and fill against exterior walls of structures as indicated on the Drawings; as embankment fill; or in other areas as designated by the ENGINEER. Material conforming to the requirements of common fill shall be placed in layers having a maximum thickness of 2-ft measured before compaction.
- B. Common Fill shall be compacted to at least 95 percent of maximum density as determined by ASTM D1557, Method D.
- C. Materials placed in fill areas shall be deposited to the lines and grades shown on the Drawings making do allowance for settlement of the material and for the placing of loam thereon.
- D. The surfaces of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the grading plan and no soft spots or uncompacted areas will be allowed in the work.
- E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

3.02 DISPOSAL OF SURPLUS MATERIAL

- A. No excavated materials shall be removed from the site of the work or disposed of, except as specified by the ENGINEER. Materials shall be neatly piled so as to inconvenience as little as possible the public and adjoining property OWNERS until used or otherwise disposed of as specified below.
- B. Suitable excavated material shall be used for fill embankments or backfill on the different parts of the work as required.
- C. Surplus fill shall become the property of the CONTRACTOR and shall be removed and disposed offsite.

3.03 DISPOSAL AND REPLACING OF ROCK

- A. Remove and dispose of all pieces of ledge and boulders which are not suitable for use in other parts of the work. Rock disposed of by hauling away to spoil areas is to be replaced by approved surplus excavation obtained elsewhere on the work, insofar as it is available. Any deficiency in the backfill material shall be made up with acceptable material approved by the ENGINEER.

- B. Fragments of ledge and boulders smaller than 50 lb weight may be used in backfilling trenches unless in the opinion of the ENGINEER the quantity is excessive, in which case he/she may order the removal and disposal of some of this rock. The small pieces of rock used as backfill shall not be placed in trenches until the pipe has at least 2-ft of earth over it. Place these pieces of stone in thin layers alternating them with earth to be sure that all voids between the stones are completely filled with earth to prevent the occurrence of voids and settlement which will result therefrom.
- C. Rock may be used in embankment fill only with the approval of the ENGINEER.

3.04 GRADING

- A. Grading in preparation for placing of loam, planting areas, paved walks and drives and appurtenances shall be performed at all places that are indicated on the Drawings, to the lines, grades and elevations shown and otherwise as directed by the ENGINEER and shall be performed in such a manner that the requirements for formation of embankments can be followed. All material encountered, of whatever nature, within the limits indicated, shall be removed and disposed of as directed. During the process of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.
- B. If at the time of grading it is not possible to place any material in its final location, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.
- C. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, in order to obtain satisfactory construction.
- D. Stones or rock fragments larger than 4-in in their greatest dimensions will not be permitted in the top 6-in of the finished subgrade of all fills.

END OF SECTION 31 00 00

SECTION 31 11 00 - CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the requirements for Site clearing which may consist of:
1. Protection of trees indicated to be preserved.
 2. Protection of above-ground and below-ground existing improvements indicated to be preserved.
 3. Clearing, grubbing, removal and disposal of trees, stumps, brush, roots, vegetation, logs and rubbish.
 4. Removal and disposal of above-ground and below-ground materials and existing improvements, including building demolition if any, as indicated.
 5. Stripping and stockpiling of topsoil.
 6. Stripping and stockpiling natural leaf mulch.

1.2 SUBMITTALS

- A. In accordance with Section 01 33 00 – Submittal Procedures.

1.3 JOB CONDITIONS

- A. Conduct demolition operations and removal of debris in accordance with governing regulations and Section 024117 - Demolition of these Specifications.
- B. Ensure minimum interference with adjacent occupied or used facilities.
- C. Exercise care to protect adjacent building, structures, and persons.
- D. Above-ground and below-ground existing improvements, indicated to remain, shall be protected from damage prior to and during construction operations.
- E. Tree Protection
1. Trees to be preserved shall be protected by barricades to avoid any confusion and damage prior to site clearing operations.
 2. Contractor shall install barricades 3 ft. beyond drip line of trees to be protected. Construction equipment or storage activities shall not be permitted within the fenced area.
- F. Protection of Existing Utilities and Adjacent Work
1. Prior to earthwork operations, existing utilities, facilities and permanent objects to remain shall be located and adequately protected. When working near public and private utility company lines, Contractor shall contact the local utility coordinating committee, or the utility company involved to locate their lines.

2. If unknown and uncharted utilities are encountered during excavation, promptly notify Owner and the governing utility company when determinable and wait for instructions.
3. If it is determined by Owner that such utility line has been abandoned, properly cap line at a depth approved by Owner or remove line as directed.
4. If such unknown utilities are encountered and work is continued without contacting the Owner for instructions, and the encountered utilities are damaged by continuation of the work, Contractor shall repair, at this own expense, such damage to the satisfaction of the Owner and the Utility Company. The Contractor shall be responsible for all costs to repair the damage.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CLEARING

- A. Trees to be removed, stumps, brush, roots and vegetation shall be removed to a depth of not less than 2 feet below original or finish ground level, whichever is lower.
- B. Miscellaneous vegetation, logs and rubbish shall be removed in their entirety, within the limits of improvements.
- D. Topsoil shall be stripped to underlying subsoil. Topsoil shall be defined as friable organic clay loam surface soil, reasonably free of clay lumps, stones, weeds, roots and other objectionable material. Topsoil shall be safely stockpiled on the Site. Stockpiles shall be constructed to freely drain surface water.
- E. Depressions caused by clearing, grubbing and stripping operations shall be filled with approved backfill material, unless further excavation is required by the construction operations. Backfill shall be placed in accordance with Section 312300 – Grading, Excavation and Fill of these Specifications.

3.2 REMOVAL OF IMPROVEMENTS

- A. Above-ground and below-ground existing improvements shall be removed in their entirety, except for utilities which shall be removed only to the extent indicated. Where utilities are indicated to be removed in part, the ends of the remaining utilities shall be permanently plugged with Class 3000 concrete.

3.3 DISPOSAL OF MATERIALS

- A. Materials not scheduled to be salvaged shall become the property of the Contractor and shall be removed from the Site and legally disposed of. Burning or burying cleared, grubbed and demolition waste materials on the Site shall not be permitted.
- B. Remove items, without damaging, scheduled to be salvaged as directed by the engineer and placed in designated storage area.

END OF SECTION 31 11 00

SECTION 31 23 00 – GRADING EXCAVATION AND FILL

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. PROTECTION OF TREES.
- B. FIELD ENGINEERING FOR SITE LAYOUT.
- C. TESTING LABORATORY SERVICES.
- D. FILL MATERIAL FOR PAVEMENT SUBBASE.
- E. CONCRETE REINFORCING.
- F. CAST-IN-PLACE CONCRETE.
- G. INFORMATIONAL REFERENCE TO SITE SURVEY AND TO SUBSURFACE CONDITIONS.

1.2 QUALITY ASSURANCE

- A. REFERENCE STANDARDS:
 - 1. ASTM D 698, TEST FOR MOISTURE-DENSITY RELATIONS OF SOILS (STANDARD PROCTOR).
 - 2. ASTM D 2922, TEST FOR DENSITY OF SOIL IN PLACE BY NUCLEAR METHOD.
 - 3. ASTM D 2487, CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES.

1.3 SUBMITTALS

- A. SAMPLES:
 - 1. SUBMIT 10 POUND SAMPLE QUANTITY OF FILL MATERIALS.
 - 2. SUBMIT 20 POUND SAMPLE QUANTITY OF TOPSOIL MATERIAL.
 - 3. PACK TIGHTLY IN CONTAINERS TO PREVENT CONTAMINATION.

1.4 GRADES

- A. CAREFULLY COMPARE NEW GRADE REQUIREMENTS WITH EXISTING CONDITIONS.
- B. PROVIDE NECESSARY EARTH, GRADING AND SHAPING WORK.
- C. EXTRA PAYMENT WILL NOT BE AUTHORIZED FOR OVERAGE OR SHORTAGE OF MATERIAL.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. SUB BASE MATERIAL: UNWASHED PIT RUN OR CRUSHED GRAVEL, CRUSHED STONE, OR CRUSHED SLAG, NATURALLY OR ARTIFICIALLY GRADED WITH MAXIMUM AGGREGATE SIZE OF 1-1/2 INCHES, AS ACCEPTABLE TO TESTING LABORATORY.
- B. BACKFILL AND FILL MATERIAL: SOIL MATERIALS FREE OF DEBRIS, WASTE, FROZEN MATTER, VEGETABLE AND OTHER DELETERIOUS MATTER, AS ACCEPTABLE TO TESTING LABORATORY.
- C. SELECT FILL: IMPORTED LEAN CLAY WITH A NARROW PLASTICITY INDEX (PI) RANGE OF 10 TO 15.
- D. LIME TREATED STRUCTURAL FILL: ON-SITE CLAY MIXTURE, FREE OF SILT, LOAM, FRIABLE OR SOLUBLE MATERIALS AND ORGANIC MATTER; TREATED IN 6 INCH LIFTS WITH 36 POUNDS PER SQUARE YARD OF HYDRATED LIME.
- E. BACKFILL:
 - 1. FREE FROM ROCKS LARGER THAN 3 INCHES IN SIZE, ALKALI, SALT, PETROLEUM PRODUCTS, DEBRIS, WASTE, ROOTS, VEGETABLE AND OTHER DELETERIOUS MATTER.
 - 2. EXCESS NON-VEGETATED EXCAVATED SOILS AVAILABLE FROM SITE MAY BE USED IF CONFORMING TO SPECIFIED REQUIREMENTS.
- F. LIME: MATERIAL CONFORMING TO SDHPT ITEM 264, "HYDRATED LIME AND LIME SLURRY".
- G. SOIL FILTER FABRIC: MIRAFI "1405" IS SPECIFIED; DUPONT "TYPAR" IS ACCEPTABLE, OR APPROVED EQUAL.

PART 3 EXECUTION

3.1 OBSTRUCTIONS

- A. REMOVE OBSTRUCTIONS WITHIN LINES OF IMPROVEMENTS.
- B. REFER OBSTRUCTIONS OF QUESTIONABLE NATURE TO ENGINEER.
- C. REMOVE ABANDONED FOUNDATIONS DOWN TO 12 INCHES BELOW FINISHED GRADE, OR THE FINISHED ELEVATION OF PAVEMENTS AND WALKS UNLESS INDICATED OTHERWISE ON THE DRAWINGS.
- D. REMOVE FOUNDATIONS OF LIGHT STANDARDS COMPLETELY.

3.2 STRIPPING

- A. STRIP ENTIRE AREA TO RECEIVE PAVEMENT AND SLABS ON GRADE TO A MINIMUM DEPTH OF SIX INCHES TO REMOVE SOIL CONTAINING VEGETATED MATERIAL.

- B. REMOVE VEGETATED MATERIAL FROM SITE AS WASTE.
- C. REMOVE TOPSOIL; SPREAD ON AREAS ALREADY GRADED AND PREPARED FOR TOPSOIL, OR DEPOSIT IN STORAGE PILES CONVENIENT TO AREAS SUBSEQUENTLY TO RECEIVE TOPSOIL.
- D. SCARIFY EXISTING ASPHALT SURFACING AND FLEXIBLE BASE COURSE MATERIAL AND REMOVE FROM SITE.
- E. REMOVE EXISTING SITE IMPROVEMENTS IN AREAS SCHEDULED TO RECEIVE LAWNS, BUILDINGS, AND PAVEMENTS.
- F. STRIPPED MATERIAL BECOMES PROPERTY OF CONTRACTOR; REMOVE FROM PROJECT SITE IMMEDIATELY AND DISPOSE OF PROPERLY.
- G. MAINTAIN SITE SURFACE DRAINAGE DURING CONSTRUCTION.

3.3 EXCAVATION AND COMPACTION BELOW GRADE BEAMS AND SLABS-ON-GRADE

- A. EXCAVATE SUB GRADE FOR THE BUILDING FOOTPRINT TO ALLOW A MINIMUM OF 4 FEET OF THICKNESS BELOW THE BOTTOM OF THE SLABS-ON-GRADE .IN ACCORDANCE WITH LINES AND GRADES REQUIRED FOR CONSTRUCTION OF THE WORK, INCLUDING SPACE FOR PLACING AND REMOVAL OF FORMS, BRACING AND SHORING, FOR INSPECTION AND A MINIMUM OF 5 FEET BEYOND THE BUILDING LINE.
- B. MAINTAIN EXCAVATIONS FREE OF LOOSE EARTH, DEBRIS, AND KEEP DRY UNTIL PLACEMENT OF CONCRETE.
- C. PROOF ROLL THE SOIL AT THE BASE OF THE EXCAVATION USING A RUBBER-TIRED VEHICLE WEIGHING ABOUT 20 TONS, SUCH AS A LOADED DUMP OR WATER TRUCK.
- D. REMOVE AND REPLACE ANY SOFT OR WEAK SOILS IDENTIFIED. DISKING, DRYING AND RECOMPACTION DURING DRY WEATHER OR TREATMENT WITH A CHEMICAL ADDITIVE MAY BE USED AS NEEDED AS REMEDIAL OPTIONS.
- E. PLACE A MINIMUM 3 FEET THICKNESS STRUCTURAL FILL AND SELECT AS RECOMMENDED BY THE SOILS REPORT, FILL AS INDICATED, IN CONSECUTIVE 8 INCH MAXIMUM LOOSE LIFTS. COMPACT ANY LIME TREATED CLAY AND SELECT FILL TO AT LEAST 95 PERCENT OF THE STANDARD PROCTOR MAXIMUM DENSITY ACCORDING TO ASTM D 698.
- F. IF HIGH MOISTURE CONTENT IS DETERMINED BY ASTM D698, COMPARE THE IN-PLACE DENSITY OF LIME- TREATED CLAYS WITH 90 PERCENT OF THE MAXIMUM DENSITY DETERMINED BY MODIFIED EFFORT ACCORDING TO ASTM D 1557, IF REQUIRED. THE ACTUAL RANGE OF MOISTURE WITHIN WHICH SPECIFIED COMPACTION CAN BE ACHIEVED MAY BE ADJUSTED ONCE THE MOISTURE-DENSITY RELATIONSHIP FOR THE STRUCTURAL FILL HAS BEEN DEVELOPED.
- G. PROTECT OPEN EXCAVATIONS WITH COVERINGS AS NECESSARY TO MAINTAIN

EXISTING SOIL MOISTURE CONTENT.

3.4 EXCAVATION FOR UTILITY TRENCHES

- A. EXCAVATE USING LADDER-TYPE TRENCHING MACHINE OR BACKHOE UNLESS INDICATED OTHERWISE.
- B. CUT TRENCH SIDES VERTICAL FROM TRENCH BOTTOM TO ONE FOOT ABOVE TOP OF PIPE; SLOPE BACK ON STABLE SLOPE ABOVE THAT POINT.
- C. EXTEND TRENCH WIDTH MINIMUM 6 INCHES AND MAXIMUM 18 INCHES EACH SIDE OF PIPE.
- D. EXCAVATE TRENCH TO A MINIMUM DEPTH OF 4 INCHES BELOW BOTTOM ELEVATION OF PROPOSED PIPELINES.
- E. LEAVE NO MORE THAN 500 FEET OF TRENCH OPEN AT ONE TIME.
- F. WHERE AUGURED HOLE IS INDICATED, PROVIDE OPENING NO LARGER THAN ONE INCH GREATER THAN OUTSIDE DIAMETER OF PIPE BELL.

3.5 DEWATERING

- A. KEEP EXCAVATIONS DRY; MAINTAIN DEWATERED CONDITION FOR DEPTH OF ONE FOOT BELOW EXCAVATION BOTTOM.
- B. OPERATE SUITABLE PUMPS NECESSARY TO KEEP EXCAVATIONS CONTINUOUSLY FREE OF WATER.
- C. DISCHARGE DRAINAGE WATERLINES INTO APPROVED SEWERS ONLY WITH APPROPRIATE APPROVALS; USE OF SANITARY SEWER IS PROHIBITED.
- D. DIRECT SURFACE DRAINAGE AWAY FROM EXCAVATED AREAS.
- E. CONTROL GRADING ADJACENT TO EXCAVATIONS TO PREVENT WATER RUNNING INTO EXCAVATED AREAS.

3.6 PERIMETER BACKFILL

- A. BACKFILL EXTERIOR SIDE OF PERIMETER OF STRUCTURE WITH LIME-TREATED ON-SITE CLAY MATERIALS, CARRYING SUCH FILL UP TO INDICATED SUB GRADES.
- B. BACKFILL SYSTEMATICALLY AND AS EARLY AS POSSIBLE TO ALLOW MAXIMUM TIME FOR NATURAL SETTLEMENT AND COMPACTION.
- C. COMMENCE BACKFILLING AFTER UNDERGROUND WORK HAS BEEN INSPECTED, TESTED, FORMS REMOVED, AND EXCAVATION CLEANED OF TRASH AND DEBRIS.
- D. PLACE AND COMPACT BACKFILL TO MINIMIZE SETTLEMENT AND AVOID DAMAGE TO WORK IN PLACE.
- E. PLACE BACKFILL SIMULTANEOUSLY ON BOTH SIDES OF FREESTANDING

STRUCTURES; PREVENT WEDGING ACTION AGAINST STRUCTURE.

- F. PLACE MATERIALS IN SUCCESSIVE HORIZONTAL LAYERS OF NOT MORE THAN 8 INCHES (4 INCHES FOR HAND- HELD TAMPING EQUIPMENT) AND UNIFORMLY COMPACTED TO 92% OF MAXIMUM DENSITY AS CONFIRMED BY TESTING LABORATORY.

3.7 UTILITY TRENCH BACKFILL

- A. PIPE BEDDING AND BACKFILL REQUIREMENTS FOR SANITARY SEWERS SHALL BE AS SPECIFIED IN SECTION 333100, SANITARY SEWAGE SYSTEMS.
- B. PIPE BEDDING AND BACKFILL REQUIREMENTS FOR STORM SEWERS SHALL BE AS SPECIFIED IN SECTION 334100, STORM SEWAGE SYSTEMS.
- C. PIPE BEDDING AND BACKFILL FOR WATER DISTRIBUTION SYSTEM PIPING SHALL BE AS SPECIFIED IN SECTION 321100, WATER DISTRIBUTION SYSTEMS.
- D. BACKFILL TRENCH AS SOON AS POSSIBLE AFTER PIPE HAS BEEN LAID, JOINTED, AND INSPECTED; COMPLETE BACKFILLING AT END OF EACH DAY.
- B. WITHIN PIPE ZONE: PLACE BACKFILL MATERIAL AND HAND TAMP IN 6 INCH LAYERS TO ONE FOOT ABOVE TOP OF PIPE.
- E. USE OF BULLDOZER OR SIMILAR TRACKED EQUIPMENT IS UNACCEPTABLE FOR COMPACTION.

3.8 PREPARATION OF SUBGRADE FOR PAVING, WALKS AND EXTERIOR SLABS

- A. CUT AND FILL AREAS AS REQUIRED.
- B. PROOF ROLL SUB GRADE WITH HEAVY ROLLER. CUT OUT ANY SOFT AREA THAT CANNOT BE COMPACTED BY SURFACE ROLLING AND REPLACE WITH COMPACTED SELECT FILL.
- C. PROVIDE SELECT FILL AT AREAS WHERE REQUIRED TO ELEVATE SUB GRADE. LIME STABILIZATION: STABILIZE TO DEPTH OF 8 INCHES WITH LIME SLURRY IN ACCORDANCE WITH TXDOT ITEM 260. **SUBGRADE BENEATH SIDEWALKS SHALL NOT BE LIME STABILIZED.**
- D. COMPACT TO NOT LESS THAN 85 TO 92% OF MAXIMUM DENSITY IN ACCORDANCE WITH ASTM D698 AS CONFIRMED BY TESTING LABORATORY; WITH MOISTURE CONTENT FOR COMPACTED MATERIAL WITHIN +/- 2% OF OPTIMUM MOISTURE.
- E. MAINTAIN SITE SURFACE DRAINAGE DURING CONSTRUCTION.

3.9 ROUGH GRADING

- A. SHAPE SUB GRADE TO ALLOW FOR MAXIMUM AMOUNT OF NATURAL SETTLEMENT AND COMPACTION.

- B. REMOVE DEBRIS, ROOTS, BRANCHES, STONES, IN EXCESS OF 2 INCHES IN SIZE.
- C. REMOVE SUBSOIL WHICH HAS BEEN CONTAMINATED WITH PETROLEUM PRODUCTS.
- D. EXCAVATE AREAS, TO SUB GRADE ELEVATION, WHICH ARE TO RECEIVE PAVING AND SIDEWALKS.
- E. BRING SUB GRADE TO REQUIRED LEVELS, PROFILES AND CONTOURS, MAKING GRADUAL CHANGES IN GRADE; BLEND SLOPES INTO LEVEL AREAS.
- F. SLOPE GRADE AWAY FROM BUILDING MINIMUM 2 INCHES IN 10 FEET UNLESS INDICATED OTHERWISE.
- G. CULTIVATE SUB GRADE TO A DEPTH OF 3 INCHES WHERE TOPSOIL IS TO BE PLACED; REPEAT CULTIVATION IN AREAS WHERE EQUIPMENT USED FOR HAULING AND SPREADING TOPSOIL HAS COMPACTED SUB GRADE.
- H. MAINTAIN SITE SURFACE DRAINAGE DURING CONSTRUCTION.

3.10 SURPLUS MATERIALS

- A. REMOVE SURPLUS SUBSOIL FROM SITE.
- B. LEAVE STOCKPILE AREAS AND ENTIRE JOB SITE CLEAN AND RAKED, READY TO RECEIVE LANDSCAPING.

3.11 CLEAN-UP

- A. REMOVE TEMPORARY STRUCTURES, RUBBISH, AND WASTE MATERIALS FROM WORK SITE DAILY.

END OF SECTION 31 23 00

SECTION 31 25 00 – EROSION AND SEDIMENTATION CONTROL

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. This Section pertains to the provisions for the control of erosion in the construction area and in stockpile areas including seeding, the construction of temporary swales and sedimentation basins as required and shown on the drawings. All areas where existing vegetation and grass cover have been bared by construction activities shall be protected from erosion.
- B. Contractor is responsible for meeting all local, state and federal regulations regarding erosion control including the applicable provisions of the National Pollution Discharge Elimination System, Phase II, regulations from the Clean Water Act.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including A-Procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.
- B. Section 02 41 17 - Demolition
- C. Section 31 11 00 - Clearing and Grubbing
- D. Texas Department of Transportation's Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (2014)

1.3 PERMITS (NOT USED)

1.4 APPLICABLE PUBLICATIONS (NOT USED)

1.5 PROTECTION OF ADJACENT WORK (NOT USED)

1.6 DEFINITIONS

- A. Best Management Practices (BMP's) means physical facilities schedules of activities, prohibition of practices, maintenance procedures, and other management practices , when properly designed, installed, and maintained, will be effective to prevent or reduce the discharge of pollution associated with construction activities. BMP's also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

- B. Block Sodding: Sodding for erosion control and for final stabilization shall consist of providing and planting Bermuda grass, San Augustine grass, or other acceptable sod along or across such areas as are designated on the drawings and in accordance with the specification requirements herein outlined.
- C. Hydromulch Seeding: Seeding, followed by the application of a mulch erosion control blanket shall consist of preparing the ground, sowing of seeds, application of a fertilizer, and stabilization with mulch consisting of a biodegradable fiber along and across such areas as are designated on the plans and in accordance with these specifications
- D. Silt Fence: The reinforced filter fabric barrier consists of geotextile fabric supported by a net reinforced fence stretched across and attached to supporting posts or frame and entrenched. Work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation as designated on the plans and in accordance with these specifications.
- E. Inlet Protection Barriers: The inlet protection barrier consists of a geotextile fabric (filter fabric) supported by a net reinforced fence structure and constructed around a storm drain inlet, catch basin, or culvert. An alternative design of the inlet protection barrier, as approved by the Engineer, consists of fiber rolls placed around a frame, staked in place (or weighted down with clean gravel bags), and constructed around a storm drain inlet, catch basin or culvert. This work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation. As designated on the plans and in accordance with these specifications.
- F. Sediment Basins: A sediment basin is a temporary basin or dam constructed across a waterway or excavated location to intercept sediment-laden runoff and to trap and retain the sediment. A sediment basin is usually installed at points of discharge from drainage areas greater than 5 acres. Work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation as designated on the plans and in accordance with these specifications.
- G. Stabilized Construction Access: This work shall consist of the installation of temporary erosion protection and sediment control stabilized construction access - type I, rock, utilized during construction operations and prior to final stabilization, in accordance with these specifications and construction drawings
- H. Rock Filter Dams: Rock filter dams are temporary berms constructed of stone to intercept and slow storm water runoff to retain sediment on the construction site.
 - 1. Depending upon the type of rock filter dam specified in the construction plans as Type 1, 2, 3, or 4, the aggregate fill may be unwrapped, wrapped in twisted hexagonal wire mesh, or confined in a gabion wire basket. Applications of Rock Filter Dams are as follows:
 - a. Type 1 dams may be used at toe of slopes, around inlets, in small ditches, and at dike or swale outlets. Type 1 dams are recommended for erosion and sediment control from a drainage area of 5 acres or less.
 - b. Type 2 dams may be used in ditches and at dike or swale outlets.
 - c. Type 3 dams may be used in stream fl
 - d. Type 4 sack gabions may be used in ditches and smaller channels to form an erosion and sediment control dam

1.7 QUALITY ASSURANCE

- A. Codes and Standards: Install and maintain erosion control systems in compliance with all authorities having jurisdiction.

1.8 PROJECT/SITE CONDITIONS (NOT USED)

1.9 SUBMITTALS (NOT USED)

PART 2 – PRODUCTS

2.1 SUSTAINABLE MATERIALS

- A. Contractor shall strive to utilize sustainable materials, which include rapidly renewable materials, regional materials, regionally manufactured materials, regionally extracted materials, recycled contents.

2.2 GRASS

- A. Materials for erosion control seeding shall conform to TxDOT Item 164.
- B. Materials for erosion control sodding shall conform to TxDOT Item 162.

2.3 FERTILIZER

- A. Materials for fertilizing erosion control seeding and/or sodding shall conform to TxDOT Item 166.2

2.4 WATER

- A. Use clean potable water for maintaining the grass developed after erosion control seeding and/or sodding. Water shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.
- B. Water sources other than the local municipal domestic water supply must be approved by the Owner.
- C. If onsite reclaimed water sources are used, tanks and appertices must be clearly marked with the words “non-potable” water.

2.5 SILT FENCE

- A. Geotextile fabric for Silt Fences must meet the TxDOT Departmental Material Specifications DMS 6230 Temporary Sediment Control Fence Fabric.

2.6 STRAW BALES

- A. Standard rectangular hay bales bound by baling wire, clean and dry

2.7 INLET PROTECTION BARRIERS

- A. Geotextile per 2.5 Silt Fence above.
- B. Hardwood Posts shall be 2x2 minimum length 4 feet.
- C. Net reinforced fence shall be 2 inch by 4 inch welded wire fabric mesh. The mesh support height shall be the equivalent height, or greater, of the geotextile fabric to be attached.

2.8 STABILIZED CONSTRUCTION ACCESS

- A. Materials to be per TxDOT spec section 506.2.E.1 for Type 1

2.9 ROCK FILTER DAM

- A. Materials. Geotextile fabric shall consist of a woven monofilament or spun bond nonwoven fibers consisting of long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins. Geotextile fabric shall equal or exceed the following average roll values or as directed by the Engineer:
 - 1. Minimum average roll value.
 - a. Elongation – 50 percent.
 - b. Grab Strength – 200 pounds.
 - c. Puncture Strength – 75 pounds.
 - d. UV Stability (retained strength) – 50 percent after 500 hours of exposure.
 - 2. Maximum average roll value.
 - a. Apparent Opening Size (AOS) – 0.6 mm/#30 US sieve.
- B. Geotextile fabric shall be resistant to commonly encountered soil chemicals, mildew, rot, insects, and deterioration resulting from exposure to sunlight or heat. Geotextile fabric shall provide an expected useable life comparable to the anticipated construction period.
- C. Aggregate for the rock filter dams shall consist of crushed stone. Aggregate particles shall be composed of clean, hard, durable materials free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials or organic and injurious matter. Aggregate shall be cubic or rounded form, not elongated, flat, shapes. Spalls, fragments, and chips shall not exceed 5 percent by weight. Crushed concrete shall not be substituted for the crushed stone unless as approved by the Engineer. Aggregate size shall depend upon the type of rock filter dam specified in the construction plans. Aggregate size based on type of rock filter dam is as follows:

1. Type 1: 3 inches to 5 inches, open-graded.
 2. Type 2: 3 inches to 5 inches, open-graded.
 3. Type 3: 4 inches to 8 inches, open-graded.
 4. Type 4: 3 inches to 5 inches, open-graded.
- D. Mesh is required for reinforced type rock filter dams. Mesh shall be 20 gauge galvanized double twisted hexagonal wire mesh with 1-inch diameter hexagonal openings. Mesh wire shall be zinc coated prior to being double twisted. Reinforcing spiral binders, lacing wire, and stiffeners shall be made of wire having the same coating material and same wire size as the wire mesh. Gabion wire baskets shall equal or exceed the requirements of the wire mesh.

PART 3 – EXECUTION

3.1 GENERAL

- A. Protection
1. Protect benchmarks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, existing curbs, and other features indicated on Drawings to remain, or not indicated to be removed, from damage and displacement. If damaged or displaced, notify Engineer and correct defects as directed.
 2. Protect above and below grade utilities which are to remain.
- B. Preparation:
1. Use all means necessary to control dust on and near the work, and on and near off-site storage, and spoil areas, if such dust is caused by performance of the work of this Section, or if resulting from the condition in which Project Site is left by Contractor.
 2. Moisten surfaces, as required, to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other work on Project Site.
- C. Install erosion control systems at the site's boundary at locations where stormwater runoff will leave the site prior to starting any clearing, stripping, or earthwork operations
- D. Minimize the time areas are to be exposed without vegetative cover.
- E. Properly dispose of solid waste, paints, solvents, cleaning compounds, etc.
- F. Store construction materials in designated areas away from drainageways and low areas.
- G. Provide portable toilets and properly dispose of sanitary sewage.
- H. Construct containment berms and utilize drip pans at fuel and liquid storage tanks and containers.

3.2 INSTALLATION OF EROSION CONTROL DEVICES

- A. Install erosion control devices to protect adjacent and downstream properties from damage and pollution resulting from erosion caused by the work of this Contract.
 - 1. Implement erosion control measures indicated on drawings and additional erosion control measures necessary to prevent damage to adjacent and downstream properties.
- B. Install silt fence located along perimeter of site or grading limits immediately following site clearing operations specified under Section 31 11 00 Clearing and Grubbing.
 - 1. Install silt fence fabric from a continuous roll for the length of the silt fence whenever possible to minimize the number of joints.
 - a. Create joints in fabric by securely fastening fabric at the support post with overlap extending to the next post.
 - 2. Drive support post into ground not less than 18 inches.
 - 3. Excavate a 4-inch-wide by 4-inch-deep trench on up-slope side of silt fence.
 - a. Line trench with silt fence fabric material.
 - b. Backfill trench with soil or gravel.
- C. Install straw bale fence at completion of grading operations in affected area as indicated on drawings.
 - 1. Install erosion control devices at storm sewer inlets immediately after completion of the storm sewer.
 - 2. Place straw bales in a single row, lengthwise on the contour, and embedded 4 inches into soil.
 - 3. Secure each individual bale in place by stakes or reinforcement bars driven through bales into the ground to a depth of not less than 18 inches.
- D. Install inlet protection barriers at curb inlets and at area inlets.
- E. Install straw bale fences as ditch checks in drainage ditches.
- F. Install Stabilized Construction Access per TxDOT specification 506.4.C.5.
- G. Rock filter dams shall be installed so as to prevent downstream deposition of sediment and debris from the construction site. Rock filter dams shall be constructed to meet the following criteria:
 - 1. Type 1:
 - a. Non-reinforced.

- b. Height: 18-24 inches
 - c. Top width: 2 feet minimum.
 - d. Upstream and downstream side slope of dam: 2:1 maximum.
 - e. Open graded aggregate 3-5 inches.
2. Type 2:
- a. Reinforced with wire mesh.
 - b. Height: 18-36 inches.
 - c. Top width: 2 feet minimum.
 - d. Upstream and downstream side slope of dam: 2:1 maximum.
 - e. Open graded aggregate 3-5 inches.
3. Type 3:
- a. Reinforced with wire mesh.
 - b. Height: 36-48 inches.
 - c. Top width: 2 feet minimum.
 - d. Upstream and downstream side slope of dam: 3:1 maximum.
 - e. Open graded aggregate 4-8 inches.
4. Type 4:
- a. Reinforced in a gabion wire basket.
 - b. Height: 30 inches minimum.
 - c. Top width: 2 feet minimum.
 - d. Upstream and downstream side slopes of dam: none specified.
 - e. Open graded aggregate 3-5 inches.
5. The separation geotextile fabric and wire mesh shall be sized and placed in accordance with the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The separation geotextile fabric may be omitted only as approved by the Engineer. The separation geotextile fabric and wire mesh shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel prior to aggregate placement. Sack gabions for Type 4 rock filter dams

shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel, as well.

6. Aggregate fill shall be placed to the width, length, height and slopes in accordance with this specification and the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The height of the dam shall be measured vertically from the existing ground to the top of the filter dam. The length of the dam shall be measured across the top centerline of the dam from embankment to embankment and includes the additional length embedded into the embankment. Width of the dam shall be measured along the top face of the dam.
7. Wire mesh shall be folded upstream side over the aggregate fill and tightly secured to itself on the downstream side using wire ties. Hog rings may be substituted for wire ties.
8. Additional aggregate fill or gravel bags shall be placed and secured at the embedded section to prevent low flows from short circuiting the dam at the adjacent dirt embankment area.
9. The Contractor shall be responsible for periodic reshaping, repairing, and maintaining of rock filter dams as directed by the Engineer.
10. The Contractor is responsible for removal and proper disposal of sediment and debris from the rock filter dam. Removed sediment and debris shall not be allowed to flush into the storm sewer system, waterways, jurisdictional wetlands, or onto adjacent properties. Sediment deposits shall be removed before they reach one-third of the height of the dam. Uncontaminated sediment can be placed at the project spoil site or, if properly handled, spread out to supplement fill requirements. If sediment has been contaminated, then it shall be disposed of in accordance with the applicable federal, state, and local regulations. Offsite disposal shall be the responsibility of the Contractor. Contractor is encouraged to reuse aggregate and wire mesh if remaining materials meet original specifications.

3.3 EROSION CONTROL SEEDING

- A. Exposed fill and stockpile areas shall be protected from windborne erosion if the phasing of the construction operations is anticipated to leave the exposed fill and stockpile areas unattended for 6 weeks or more. At completion of stockpiling operations, stockpiles shall be shaped and graded to drain. Provide a layer of mulch to all sides of the stockpile to protect the stockpile from windborne erosion.
- B. Areas designated on the drawings to be seeded shall be seeded in accordance to the Texas Department of Transportation Standard Specifications, Item 164, titled "Seeding for Erosion Control". Broadcast seeding method shall be used as described in TxDOT, Item 164.4 unless otherwise instructed.
- C. Areas to be seeded with slopes steeper than 10H:1V shall also utilize a soil retention blanket as specified in TxDOT Item 169 Soil Retention Blanket.

3.4 TEMPORARY SWALES

- A. Temporary drainage swales shall be provided as required to carry drainage away from the work area to an approved outfall point.
- B. Unless otherwise shown on the drawings, swales shall be earthen "V" shaped channels graded to a sufficient depth and slope to carry the anticipated runoff, but at least two (2) feet deep with a slope of 0.1%.
- C. Swales not designated to remain in place at the completion of the contract shall be cleaned of any muck, debris and other unsuitable material and filled with approved fill before final grading operations begin.
- D. Swales shall have erosion control barriers as required in these specifications.

3.5 FILL AND CUT SLOPES

- A. Fill slopes in all cases shall be no steeper than 3:1 unless specifically stated on the plans or approved by the Owner's Geotechnical engineer.
- B. When cut slopes exceed 2:1 for depths over three (3) feet, proper bracing and shoring per OSHA requirements shall be used and maintained.
- C. For permanent slopes, cut or fill, between 2:1 and 10:1, erosion protection shall be provided with hydromulching seeding, sodding, or other method as approved.
- D. Where cut slopes of more than 5 feet deep, extend more than 100 feet in length, contractor shall provide a backfill drain at the top of the slope to ease in drainage and erosion control.

3.6 SEDIMENTATION BASINS

- A. Sedimentation ponds shall be provided when designated on the plans.
- B. All drainage from cleared areas shall be routed through the sedimentation basin.
- C. Contractor will be responsible for the operation and maintenance of the pond during construction.

3.7 MAINTENANCE

- A. Check all erosion control measures after each rainfall event to ensure that they are in proper working order.
 - 1. Immediately restore all measures to installed condition.
 - 2. During the course of construction all temporary swales constructed for this contract shall be maintained so as to allow proper drainage from the construction area. Before Contractor leaves the site at the end of construction, all temporary swales must be reworked to meet final conditions as set forth in the drawings and specifications.
 - 3. The Contractor shall assure that all subwork with other contractors at the site

understand the importance of the erosion control features. The Contractor shall require all subcontractors to respect the function of the erosion control features and enlist their coordination in maintaining existing swales and ditches.

- B. Inspect silt and straw bale fences at least once a week.
 - 1. Immediately replace damaged portions of the silt fences, including portions which have collapsed, contain tears, have decomposed, or have become ineffective.
 - 2. Remove sediment deposits, as necessary, to provide adequate sediment storage and to maintain the integrity of fences. Dispose of accumulated sediment by spreading over upland areas of the site.
- C. Maintain erosion control devices in place, as specified, until completion of the work of this Contract.
 - 1. At completion of work, inspect all systems, make necessary repairs, remove and dispose of all accumulated sediment, and turn completely operable systems over to Owner for continued maintenance.
- D. Where necessary for equipment and vehicular access to the work areas, adequately sized culverts shall be installed and maintained to provide the access without disturbing the site drainage.
- E. Sedimentation Basins.
 - 1. Contractor shall be responsible for maintaining the pond and the outfall and sediment retarding structure in good working condition throughout the time the pond is to be in operation.
 - 2. When sediment and debris fill the pond to over one third (1/3) its designed capacity, the pond shall be cleaned out.
 - 3. The sediment from the clearing operation shall be stockpiled with like materials per Specification 31 11 00 Clearing and Grubbing. If the material is found to not meet the stockpiling requirements listed in 31 11 00, they must be removed from the site as described in 31 11 00.

3.8 INSPECTIONS

- A. Inspect all erosion control systems and devices at least once every seven calendar days.
- B. Inspect all erosion control systems and devices within 24 hours of the end of any storm which results in precipitation of 1/2 inch or more.
- C. During inspections, locations where stormwater leaves the site shall be inspected for evidence of erosion or sediment deposition.
- D. Correct deficiencies within three calendar days.
- E. Complete a report of each inspection. Report shall contain the following minimum information:
 - 1. Inspector's name

2. Inspection date
3. Observations of the effectiveness of erosion control systems
4. Actions taken if necessary to correct deficiencies
5. Listing of areas where construction operations have permanently or temporarily stopped
6. Authorized signature

END OF SECTION 31 25 00

SECTION 31 63 29
DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Dry-installed drilled piers.
 - 2. Slurry displacement-installed drilled piers.
 - 3. Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.

1.3 UNIT PRICES

- A. Unit prices are included in Section 01 22 00 "Unit Prices."
- B. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length, shaft diameter, and bell diameter if applicable, may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts and bells.
 - 1. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, extended through the bell, if applicable, and the diameter of shaft and bell.
 - 2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.
- C. Trial Drilled Pier: Unit price as indicated for drilled pier, including backfilling.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.

- C. Shop Drawings: For concrete reinforcement detailing fabricating, bending, supporting, and placing.
- D. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Steel reinforcement and accessories.
- E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
- F. Field quality-control reports.
- G. Other Informational Submittals:
 - 1. Record drawings.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077, ASTM D 3740, and ASTM E 329 for testing indicated.
- C. Drilled-Pier Standard: Comply with ACI 336.1 unless modified in this Section.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
 - 1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
- B. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify all affected parties including Owner no fewer than five (5) days in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Owner's written permission.
- C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
 - 2. The geotechnical report is referenced elsewhere in the Project Manual.

- D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
 - 1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Refer Section 03 20 00.

2.2 CONCRETE MATERIALS

- A. Refer Section 03 30 00 and Structural General Notes.

2.3 STEEL CASINGS

- A. Steel Pipe Casings: ASTM A 283, Grade C, or ASTM A 36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.
- B. Corrugated-Steel Pipe Casings: ASTM A 929, steel sheet, zinc coated.

2.4 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
- C. Proportion normal-weight concrete mixture as follows:
 - 1. As indicated in Structural General Notes.

2.5 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

- A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
 1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time will be authorized for removal of obstructions.
 2. Obstructions: Unclassified excavated materials may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. Payment for removing obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work will be according to Contract provisions for changes in the Work.
- B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
- C. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
 1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
 2. Remove water from excavated shafts before concreting.
- D. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.
 1. Do not excavate shafts deeper than elevations indicated unless approved by Architect.
 2. Payment for additional authorized excavation will be according to Contract provisions for changes in the Work.
- E. Excavate shafts for closely spaced drilled piers and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set.
- F. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
 1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.

- G. Bells: Excavate bells for drilled piers to shape, base thickness, and slope angle indicated. Excavate bottom of bells to level plane and remove loose material before placing concrete.
- H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.
 - 1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.

3.3 STEEL REINFORCEMENT

- A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
- C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.
- D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.
- E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
- F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

- A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's independent testing and inspecting agency.
 - 1. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.
- B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
 - 1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
 - 2. Vibrate top 60 inches of concrete.
- C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.
 - 1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.
- D. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

- E. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

- F. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Drilled piers.
 - 2. Excavation.
 - 3. Concrete.

- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

- C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
 - 1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by testing and inspecting agency. Final evaluations and approval of data will be determined by Architect.

- D. Concrete Tests and Inspections: ASTM C 172 except modified for slump to comply with ASTM C 94.
 - 1. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
 - 2. Concrete Temperature: ASTM C 1064; 1 test hourly when air temperature is 40 deg F and below and 80 deg F and above, and 1 test for each set of compressive-strength specimens.
 - 3. Compression Test Specimens: ASTM C 31; one set of four standard 6-inch x 12-inch cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
 - 4. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and 1 specimen will be retained in reserve for later testing if required.
 - 5. If frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 6. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 - 7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

8. Report test results in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
 9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 10. Additional Tests: Testing and inspecting agency will make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Architect.
 - a. Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.
 11. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
 12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports for each drilled pier as follows:
1. Actual top and bottom elevations.
 2. Actual drilled-pier diameter at top, bottom, and bell.
 3. Top of rock elevation.
 4. Description of soil materials.
 5. Description, location, and dimensions of obstructions.
 6. Final top centerline location and deviations from requirements.
 7. Variation of shaft from plumb.
 8. Shaft excavating method.
 9. Design and tested bearing capacity of bottom.
 10. Levelness of bottom and adequacy of cleanout.
 11. Ground-water conditions and water-infiltration rate, depth, and pumping.
 12. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
 13. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
 14. Bell dimensions and variations from original design.
 15. Date and time of starting and completing excavation.
 16. Inspection report.
 17. Condition of reinforcing steel and splices.
 18. Position of reinforcing steel.
 19. Concrete placing method, including elevation of consolidation and delays.
 20. Elevation of concrete during removal of casings.
 21. Locations of construction joints.
 22. Concrete volume.
 23. Concrete testing results.
 24. Remarks, unusual conditions encountered, and deviations from requirements.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

SECTION 32 13 13 – PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the requirements for providing, placing, curing and protecting Portland cement concrete paving, with or without reinforcement as indicated, constructed on a prepared subgrade.

1.2 QUALITY ASSURANCE

- A. Reference Standards Applicable to this Section

1. ACI: American Concrete Institute
 - a. 301: Specifications for Structural Concrete for Buildings.
 - b. 316R: Recommendations for Construction of Concrete Pavements and Concrete Bases.
2. ASTM: American Society for Testing and Materials
 - a. A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (with Supplement + S1).
 - b. C 150: Specification for Portland Cement Type I or Type II.
 - c. C 309: Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - d. C 881: Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - e. D 1565: Specifications for Flexible Cellular Materials Vinyl Chloride Polymers and Copolymers (Open-Cell Foam).
 - f. D 1751: Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient bituminous Types).
 - g. D 1752: Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - h. D 3405: Specification for Joint Sealants, Hot-Poured, for Portland Cement Concrete Pavement.
3. TxDOT: Texas Department of Transportation.
 - a. Standard Specifications for Construction of Highways, Streets, and Bridges -- Latest Edition.
 - 1) Item 360, CONCRETE PAVEMENT.

B. Formwork Tolerances

Formwork tolerances shall be as specified in ACI 316 R, Chapter 5.

C. Finishing Tolerance

The top surface of pavement shall have a Class B tolerance as specified in ACI 316 R, Chapter 12.5 and ACI 301, Chapter 11.9.

D. The Portland Cement Paving Contractor/Subcontractor shall provide OWNER with evidence of his/her ability to perform the specified work. This evidence shall be in the form of at least five (5) successfully completed Portland Cement paving projects for either the **Fort Bend County, City of Sugarland** or any combination of the two.

This list of projects shall be submitted to OWNER prior to any paving operations beginning so that FBC will be able to inspect the quality of workmanship at the site and approve the Contractor/Subcontractor.

1.3 SUBMITTALS

A. In accordance with Section 01 33 00 – Submittal Procedures

1. Reinforcement Materials

a. As required in Section 032100 - Concrete Reinforcement of these Specifications.

2. Concrete Materials

a. As required in Sections 321373.19 - Cast-in-Place Concrete of these Specifications.

3. Joint Materials

a. As required in Section 321319 – Concrete Pavement Joints.

1.4 EXTENDED WARRANTY

A. Manufacturer of joint sealant shall provide at least a 1-year written warranty against material degradation or failure and water and foreign matter infiltration through the joint from the time of written acceptance of the Work. This warranty shall not limit OWNER's rights or remedies as may otherwise be afforded under law or statute.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Forms

Metal forms, as indicated in ACI 316 R, Chapter 5.

B. Welded Steel Wire Fabric

Plain wire fabric, as specified in Section 032100 - Concrete Reinforcement of these Specifications.

C. Reinforcing Steel Bars

As specified in Section 032100 - Concrete Reinforcement of these Specifications.

D. Dowel Bars

Smooth, ASTM A 615 + S1, Grade 60, new billet steel, coated with a water-resistant lubricant immediately prior to placement of concrete in which unbonded ends of bars are to be embedded.

E. Dowel Bar Sleeves

Sleeves, PVC or plastic, slightly larger than dowel bars, closed end, a minimum of 6 in. long, with 1-1/2 in. long compressible insert.

F. Concrete

Class 3000, as specified in Section 321373.19 – Cast-in-Place Concrete of these Specifications.

G. Membrane Forming Curing Compound

ASTM C 309, Type 2, unless otherwise directed.

H. Joint Materials

1. Preformed Expansion Joint Filler: ASTM D 1751, ASTM D 1752, and D 1565.
2. Joint Sealing Material: See Section 321319, Concrete Pavement Joints of these Specifications.

I. Form Coating

Commercial formulation form-coating compounds that will neither bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces. Contractor shall submit sample for approval prior to use.

J. Precast Concrete Wheel Stops

Accurately formed and finished, of size and shape as indicated, reinforced and anchored as required. Fabricate wheel stops on Site or substitute approved precast units of like design and dimensions.

K. Epoxy Bonding Grout

ASTM C 881, Type I.

PART 3 – EXECUTION

3.1 INSPECTION AND PREPARATION

- A. Prepared subgrade shall be proof rolled to check for unstable areas and need for additional compaction. Do not begin paving work until such deficiencies have been corrected and subgrade is ready to receive paving.
- B. Loose material shall be removed from the compacted subgrade immediately prior to placing concrete and subgrade shall be uniformly dampened.

3.2 SETTING FORMS

- A. Forms shall be set in accordance with the recommendations of ACI 316 R, Chapter 5, and as specified herein.
- B. Forms shall be set in sufficient quantity to allow continuous progress of concrete placement, and to ensure that forms shall remain in place not less than 24 hours.
- C. Forms shall be cleaned after each use and coated with an approved form release agent prior to each use.

3.3 INSTALLATION OF JOINTS, REINFORCEMENT, AND SEALANT

- A. Joints and reinforcement shall be installed in accordance with the recommendations of ACI 316 R, Chapter 6, as specified in Section 032100 - Concrete Reinforcement of these Specifications, and in Section 321319 - Concrete Pavement Joints.
- B. Sealant manufacturer's instructions and procedures shall be followed so as not to invalidate the warranty.

3.4 PLACING AND FINISHING CONCRETE

- A. Concrete shall be placed and finished in accordance with the recommendations of ACI 316 R, Chapters 10 and 12.5, and as specified in Section 321373.19 - Cast-in-Place Concrete of these Specifications.

3.5 CURING AND PROTECTING CONCRETE

- A. Concrete shall be cured in accordance with the recommendations of ACI 316 R, Chapter 11, using the membrane curing method and materials.
- B. Protection as recommended in ACI 316 R; Chapter 11 shall be provided until written acceptance by OWNER.

3.6 INSTALLATION OF CONCRETE WHEEL STOPS

- A. Install concrete wheel stops where indicated and in accordance with manufacturer's installation instructions as required. Where dowels are to be embedded into concrete, embed with epoxy bonding grout.

3.7 FIELD QUALITY CONTROL

A. Coring

After the pavement is placed and before final acceptance the Engineer may elect to determine pavement thickness by cores cut from the pavement or direct measurement of the edge thickness. Acceptable pavement thickness shall be deficient by no more than two tenths of an inch. Core holes shall be promptly repaired with concrete conforming to the requirements specified herein by the Contractor at no cost to OWNER.

B. Deficient Pavement Price Adjustments

Where the average thickness of pavement is deficient in thickness by more than 0.2 inch, but not more than 0.75-inch, payment will be made at an adjusted price as specified in the following table.

Concrete Pavement Deficiency

Deficiency in Thickness Determined by Cores Inches	Proportional Part of Contract Price Allowed
0.00 to 0.20	100 percent
Over 0.20 to 0.30	80 percent
Over 0.30 to 0.40	72 percent
Over 0.40 to 0.50	68 percent
Over 0.50 to 0.75	57 percent

Any area of pavement found deficient in thickness by more than 0.75 of an inch but not more than one inch or 1/8 of the plan thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants removal, the area shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness shown on the plans. Deficient pavement shall be removed for the full area of the slab between joints, or between pre-established limits.

END OF SECTION 32 13 13

SECTION 32 13 19 – CONCRETE PAVEMENT JOINTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Joints for concrete paving; concrete sidewalks, concrete driveways, curbs, and curb and gutters.
- B. Saw-cutting existing concrete or asphalt pavements for new joints.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for street pavement expansion joints, with or without load transfer, is on linear foot basis.
 - 2. Payment for horizontal dowels is on a unit price basis for each horizontal dowel.
 - 3. No separate payment will be made for formed or sawed street pavement contraction joints and longitudinal weakened plane joints. Include payment in unit price for Concrete Paving.
 - 4. No separate payment will be made for joints for Curb, Curb and Gutter, Saw-tooth Curb, Concrete Sidewalks, and Concrete Driveways. Include payment in unit price for Curb and Gutter, Concrete Sidewalks, and Concrete Driveways.
 - 5. Payment will be made for Preformed Expansion Joints on a linear foot basis only when field conditions require that sidewalk be moved adjacent to existing concrete structure (i.e., street, back of curb, etc.).
 - 6. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement. ASTM D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- B. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- C. ASTM D 3405 - Standard Specification for Joint Sealants,

Hot-Applied, for Concrete and Asphalt Pavements.

- D. TxDOT Tex-525-C - Tests for Asphalt and Concrete Joint Sealers

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit product data for joint sealing compound and proposed sealing equipment for approval.
- C. Submit samples of dowel cup, metal supports, and deformed metal strip for approval. Submit manufacturer's recommendation for placing sealant(s).

PART 2 PRODUCTS

2.01 BOARD EXPANSION JOINT MATERIAL

- A. Filler board of selected stock. Use wood of density and type as follows:
1. Clear, all-heart cypress weighing no more than 40 pounds per cubic foot, after being oven dried to constant weight.
 2. Clear, all-heart redwood weighing no more than 30 pounds per cubic foot, after being oven dried to constant weight.

2.02 PREFORMED EXPANSION JOINT MATERIAL

- A. Bituminous fiber and bituminous mastic composition material conforming to ASTM D 994 and ASTM D 1751.

2.03 JOINT SEALING COMPOUND

- A. Conform joint sealants to one of sealant classes described in this section.
- B. Conform hot-poured rubber-asphalt compound to ASTM D 3405.
- C. Two-component Synthetic Polymer.
1. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles.
 2. Cure sufficiently at average temperature of 25 ± 1 C (77 ± 2 F) so as not to pick up under wheels of traffic in maximum three hours.

3. Performance requirements, when tested in accordance with TxDOT Tex- 525-C, shall meet above curing times and requirements as follows:

Cold-Extruded and Cold-Pourable (Self-Leveling) Specifications	
Property	Requirement
Penetration, 25 C (77 F) 150 g Cone, 5 s, 0.1 mm (in.), maximum	130
Bond and Extension 50%, -29 C (-20 F), 3 cycles: *Dry Concrete Block *Steel blocks (Primed, if recommended by manufacturer) *Steel blocks shall be used when armor joints are specified	Pass Pass
Flow at 70 C (158 F)	None
Water content % by mass, maximum	5.0
Resilience: * Original sample, % min. (cured) * Oven-aged at 70 C (158 F), % min.	50 50
Cold-extruded material only - Cold Flow (10 minutes)	None

After bond and extension test, there shall be no evidence of cracking, separation or other opening that is over 3 millimeters (1/8 inch) deep in sealer or between sealer and test blocks.

4. Provide cold-extruded type for vertical or sloping joints.
5. Provide self-leveling type for horizontal joints.
- D. Self-Leveling, Low Modulus Silicone or Polyurethane Sealant for Asphaltic Concrete and Portland Cement Concrete Joints. This shall be a single component self-leveling silicone or polyurethane material that is compatible with both asphalt and concrete pavements. The sealer shall not require a primer for bond; a backer rod shall be required which is compatible with the sealant; no reaction shall occur between rod and sealant.

When tested in accordance with TxDOT Tex-525-C, self-leveling sealant shall meet following requirements:

Self-Leveling, Low Modulus Silicone or Polyurethane Sealant	
Property	Requirements
Tack Free Time, 25 ± 1 C (77 ± 2 F), minutes	120 maximum
Nonvolatile content, % by mass	93 minimum
Tensile Strength and 24-Hour Extension Test: * Initial, 10-day cure, 25 ± 1 C (77 ± 2 F), kPa (psi) * After Water Immersion, kPa (psi) * After Heat Aging, kPa (psi) * After Cycling, -29 C (-20 F), 50%, 3 cycles, kPa (psi) * 24 Hour Extension	* 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * Pass (All Specimens) After 24 hours, there shall be no evidence of cracking, separation or other opening that is over 3 mm (1/8 in.) deep at any point in the sealer or between the sealer and test blocks.

2.04 LOAD TRANSMISSION DEVICES

- A. Smooth, steel dowel bars conforming to ASTM A 615, Grade 60. When indicated on Drawings, encase one end of dowel bar in approved cap having inside diameter 1/16 inch greater than diameter of dowel bar.
- B. Deformed steel tie bars conforming to ASTM A 615, Grade 60.

2.05 SUPPORTS FOR REINFORCING STEEL AND JOINT ASSEMBLY

- A. Employ supports of approved shape and size that will secure reinforcing steel and joint assembly in correct position during placing and finishing of concrete. Space supports as directed by Project Manager.

PART 3 EXECUTION

3.01 PLACEMENT

- A. When new Work is adjacent to existing concrete, place joints at same location as existing joints in adjacent pavement.
- B. If limit of removal of existing concrete or asphalt pavement does not fall on existing joint, saw cut existing pavement minimum of 2 inches deep to provide straight, smooth joint surface without chipping, spalling or cracks.

3.02 CONSTRUCTION JOINTS

- A. Place transverse construction joint wherever concrete placement must be stopped for more than 30 minutes. Place longitudinal construction joints at interior edges of pavement lanes using No. 6 deformed tie bars, 30 inches long and spaced 18 inches on centers.

3.03 EXPANSION JOINTS

- A. Place 3/4-inch expansion joints at radius points of curb returns for cross street intersections, or as located in adjacent pavement but no further than 80 feet apart. Use no boards shorter than 6 feet. When pavement is 24 feet or narrower, use not more than 2 lengths of board. Secure pieces to form straight joint. Shape board filler accurately to cross section of concrete slab. Use load transmission devices of type and size shown on Drawings unless otherwise specified or shown as "No Load Transfer Device." Seal with joint sealing compound.

3.04 CONTRACTION JOINTS

- A. Place contraction joints at same locations as in adjacent pavement or at spaces indicated on Drawings. Place smoothed, painted and oiled dowels accurately and normal to joint. Seal groove with joint sealing compound.

3.05 LONGITUDINAL WEAKENED PLANE JOINTS

- A. Place longitudinal weakened plane joints at spaces indicated on Drawings. If more than 15 feet in width is poured, longitudinal joint must be saw cut. Seal groove with joint sealing compound.

3.06 SAWED JOINTS

- A. Use sawed joints as alternate to contraction and weakened plane joints. Use circular cutter capable of cutting straight line groove minimum of 1/4 inch wide. Maintain depth of one quarter of pavement thickness. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, continue until completed. Make saw cut with one pass. Complete sawing within 24 hours of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.
- B. Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Maintain ample supply of saw blades at work site during sawing operations. Maintain sawing equipment on job during concrete placement.

3.07 JOINTS FOR CURB, CURB AND GUTTER

- A. Place 3/4-inch preformed expansion joints through curb and gutters at locations of expansion and contraction joints in pavement, at end of radius returns at street intersections and driveways, and at curb inlets. Maximum spacing shall be 120-foot centers.

3.08 JOINTS FOR CONCRETE SIDEWALKS

- A. Provide 3/4-inch expansion joints conforming to ASTM A 1751 along and across sidewalk at back of curbs, at intersections with driveways, steps, and walls; and across walk at intervals not to exceed 36 feet. Provide expansion joint material conforming to ASTM D 994 for small radius curves and around fire hydrants and utility poles. Extend expansion joint material full depth of slab.

3.9 JOINTS FOR CONCRETE DRIVEWAYS

- A. Provide 3/4-inch expansion joints conforming to ASTM D 1751 across driveway in line with street face of sidewalks, at existing concrete driveways, and along intersections with sidewalks and other structures. Extend expansion joint material full depth of slab.

3.10 JOINT SEALING

- A. Seal joints only when surface and joints are dry, ambient temperature is above 50 degrees F and less than 85 degrees F and weather is not foggy or rainy.
- B. Use joint sealing equipment in like new working condition throughout joint sealing operation and be approved by Project Manager. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.
- C. Clean joints of loose scale, dirt, dust and curing compound. The term joint includes wide joint spaces, expansion joints, dummy groove joints or cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.
- D. Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that, upon completion, surface of sealer within joint will be 1/4 inch above level of adjacent surface or at elevation as directed.

3.11 PROTECTION

- A. Maintain joints in good condition until completion of Work.
- B. Replace damaged joints material with new material as required by this Section.

END OF SECTION 32 13 19

SECTION 32 13 73.19 – CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION

- A. This Section includes furnishing materials and installation of cast-in-place concrete as indicated on the Drawings and/or specified herein.
- B. Full cooperation shall be given to other trades to install embedded items. Suitable templates insert and sleeves shall be provided for setting items not placed in the forms.
- C. All concrete work shall conform to the requirements of ACI 318-95 and CRSI Standards, unless specifically noted otherwise.

1.02 QUALITY ASSURANCE

- A. Prior to starting concrete operations, the Contractor shall name his source of supply for concrete materials and shall submit representative samples and reports of quality tests for approval.
- B. The Contractor will engage the services of a recognized independent testing laboratory, approved by the Owner, to perform the following services, (in accordance with ASTM E 329-77) the cost of which shall be paid by the Contractor:
 - 1. Design the concrete mixtures specified, make quality tests of materials, inspect the proportioning and mixing of all concrete for this project.
 - 2. Slump Test, ASTM C-143, shall be taken as often as required to provide the specified consistency to concrete.
 - 3. Cast and test of at least 6 cylinders for each day's pour or for each 100 cubic yards or fraction thereof. Cylinders shall be cured and tested in accordance with ASTM specifications for control tests. Cylinders shall be tested at 7 and 28 days. The Contractor shall provide insulated storage room with heat when necessary to store control cylinders, and a protected, fenced-in space for storage of field cylinders, which approximates the condition of curing of the concrete being sampled.
- C. In the event that concrete fails to meet strength requirements of these Specifications, the Engineer may require at no additional cost to the Owner, tests in accordance with the "Standard Methods of Securing, Preparing and Testing Specimens of Hardened Concrete for Compressive and Flexural Strengths", ASTM C42, or order load tests in accordance with Chapter 20 of the ACI Building Code 318-95, to be made on the portions of the structure containing questionable concrete. Suitable appliances and methods of loading and measuring shall be provided by the Contractor. The portions of the structure which are found by the Architect/Engineer to contain defective concrete shall be removed and reconstructed in a satisfactory manner at the Contractor's expense. Concrete strength tests are to conform to Chapter 4 of the ACI Building Code 318-95.
- D. The laboratory shall have free access to material stockpiles, batching and mixing plants, and job site. The Contractor shall provide adequate assistance to the laboratory in securing specified samples for tests.

- E. Contractor shall give the Owner and laboratory reasonable notice before beginning any pours (at least 24 hours).
- F. The laboratory shall supply a daily report of concrete and materials testing and inspection to the Architect, Engineer, Design/Builder, Contractor and Owner.
- G. Concrete batched away from the job and delivered in mixer or agitator trucks shall conform to requirements of ASTM C94.
- H. Authority and Duties of Laboratory Personnel:
Inspectors shall inspect the materials and the manufacture of concrete as specified and shall report to the Owner's Representative, Contractor, Architect and the Engineer the progress thereof. Also, when it appears that the material furnished and the work performed by the Contractor fail to fulfill the specification requirements and contract, the inspector shall direct the attention of the Contractor to such failure or infringement. Such inspection shall not relieve the Contractor of any obligation to furnish acceptable materials or to provide the concrete quality in the structure that is in strict accord with plans and specifications. The inspector are not authorized to revoke, alter, relax, enlarge, or release any portion of the work, but in case of any dispute arising between the inspector and the Contractor as to materials furnished or in the manner of performing the work the inspector shall have the authority to reject materials or suspend the work until the question at issue can be referred to the Engineer. The inspector shall not act as foreman or perform other duties for the Contractor. In no case shall any advice or omission on the part of the inspector relieve the Contractor of responsibility for completing the work in accordance with the plans and specifications and the fulfillment of the contract. The work will be inspected as it progresses, but failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered or obligate the Engineer for final acceptance. Any expense incidental to the investigation and determination of actual quality of any questionable material shall be borne by the Contractor.
- I. Sampling and Testing:
1. All materials shall be sampled, tested in accordance with appropriate ASTM Standards, and approved before inclusion in any work on this project.
 2. Samples for testing shall be furnished by the Contractor.
 3. Rejected material shall be immediately removed from the site.
 4. Reinforcing steel shall be tested by heat in shops and by random sampling in the field when required by the Architect/Engineer or Owner.

1.03 SUBMITTALS

- A. Shop Drawings: The Contractor is to include as a part of his expense the cost of completely dimensioned concrete shop drawings embracing plans and details, bending diagrams, steel order list, placing diagrams, which service shall be furnished by a structural engineer licensed in the State of the project. No portion of the contract documents shall be reproduced and submitted as shop drawings. The shop drawings shall include the following:
1. Necessary Floor Plans – fully dimensioned plans with all depressions, rises, reinforcing steel, to include placement and accessories.
 2. Miscellaneous Items – All other reinforced concrete items shall be drawn at such scale as to give full dimensions, details and reinforcing with accessories as required.

- B. All reinforcing shall be detailed, ordered, and fabricated in accordance with the latest ACI Manual of Standard Practice for Detailing Concrete Structures and the CRSI Manual of Standard Practice.
- C. Submit Shop Drawings to the Architect for review, prior to release to field. Fabrication of reinforcing steel shall not be started until Drawings have been reviewed and stamped.
- D. Prior to the placement of any concrete, design mixes for each type of concrete shall be submitted and approved by the testing laboratory. Mix designs shall include all required and shall include each type of aggregate and admixture to be used.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Concreting shall not be started during rain, sleet or snow and shall not be continued during such weather after having been started except long enough to come to a suitable cutoff point. Concrete placed during rain shall have the cement content increased in the amount of one sack of cement per cubic yard of concrete. All forms and earth forms shall be free of ice and frozen surfaces.
- B. No concrete shall be poured unless temperature is 40 degrees and rising or unless special precautions are taken (approved by the Architect). Adequate equipment shall be provided for heating the concrete materials and protecting the concrete during freezing and near freezing weather. All concrete shall have a temperature of between 50 degrees and 90 degrees F when depositing, and shall be maintained within this temperature range for at least 72 hours or for as much time as is required to insure the proper rate of curing. No salt or other chemicals shall be added to prevent freezing. The covering or other method used for temperature protection shall remain in place 24 hours after artificial heat is discontinued. The recommended Practice for Cold Weather Concreting (ACI 306) and the "Recommended Practice for Hot Weather Concreting" (ACI 305) shall be accepted as good practice.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All materials shall be subject to approval. Any change of materials specified shall be submitted for approval and such change, if acceptable, shall be used only when specifically authorized in writing.
- B. Cement shall conform to the following specifications:
 - 1. Coarse and fine aggregate shall conform to requirements of ASTM C33 or Federal Specification SS-S-281a.
 - 2. All coarse aggregates shall be crushed limestone.
 - 3. The maximum size of coarse aggregate shall not be larger than 1", 1/5 of the narrowest dimension between forms of the member for which the concrete is to be used, nor larger than 3/4 the minimum clear spacing between reinforcing bars. Coarse aggregate for all concrete exposed to the weather shall be crushed limestone with a #57 gradation.
 - 4. Absorption in coarse aggregate shall not exceed 5%.
 - 5. The fineness modulus for fine aggregate used shall not vary more than 0.2 from the approved sample without approval. Fineness modulus to be 2.9.
- C. All concrete shall be normal weight unless specifically noted otherwise.

1. Normal weight concrete shall be approximately 145 to 155 pounds per cubic foot.
 2. Lightweight concrete shall not exceed 110 pounds per cubic foot and shall be made of normal and normal weight fines.
- D. Water shall be clean, fresh, and free from injurious amounts of oils, acids, alkali or organic material or other substances that may be deleterious to concrete or steel.
- E. Non-shrink grout shall be factory pre-mixed non-shrink, non-metallic grout containing mineral aggregate and shall require only the addition of water at the site. Grout shall be "EUCO NS" (non-metallic) as manufactured by the Euclid chemical company. "Masterflow 713" (non-metallic) as manufactured by Master Builders or approved equal. The grout shall conform to ASTM C-1107 and CRD-621, "Corps of Engineers Specifications for Non-Shrink Grout," and shall be tested in accordance with ASTM C827.
- F. Waterstops shall be 9" Dumbbell type, Model No. 751 as manufactured by Greenstreak, at locations shown on drawings.

2.02 QUALITY AND PROPORTIONING

- A. It shall be the Contractor's responsibility to furnish concrete which will conform to the quality and strength specified.
- B. Strengths, unless otherwise indicated on plans or in specifications or in the table below, shall be 3000 psi minimum 28-day compressive strength.
- | | |
|-------------------------------|----------|
| 1. Exterior Concrete (5 inch) | 3000 psi |
| 2. Exterior Concrete (6 inch) | 3600 psi |
| 3. Exterior Concrete (7 inch) | 3600 psi |
- C. Proportioning shall follow the limiting factors in the following table:
1. Proportioning on the basis of field experience shall conform to Section 5.3 of ACI 318-89 or the maximum water/cement ratio in Section 5.4 of ACI 318-89.
- D. Proportioning and design mixes shall be established to produce average strengths higher than specified by the amounts specified in Chapter 5 of ACI 318-95.
- E. Admixtures:
1. Calcium Chloride shall not be used.
 2. An approved air-entraining agent (ASTM C260) shall be added at the mixer with accurate dispenser to produce entrained air 4-6% by volume in all concrete subject to weathering conditions.
 3. An approved water-reducing agent equal to those manufactured by mixer with an accurate dispenser.
 4. These and other admixtures shall be used only with specific approval. Tests for design mixes shall be made with the admixtures included.
 5. Fly ash shall not be permitted.

F. The concrete shall be of such consistency and composition that it can be worked readily into the corners and angles of the forms and around reinforcement without permitting materials to segregate or free water to collect on the surfaces. Within the limiting requirements the Contractor shall adjust the consistency of the concrete as may be necessary to produce mixtures which will be placeable with reasonable methods of placing and compacting. The Contractor shall maintain on the job at all times adequate extra cement to be used at the rate of ½ sack cement per cubic yard concrete for each 2" slump increase for corrections due to wetness desired or obtained. No water shall be added to concrete except under the direct supervision of the engineer or his appointed representative. Under no circumstances will the addition of more than 2 gallons of water per cubic yard of concrete be allowed at the site.

G. Measurement of Materials:

1. Cement shall be measured by the sack or half-sack unless cement is weighed for each batch.
2. Aggregates shall be proportioned separately by weight with proper compensation for weight of moisture; weighing equipment shall be accurate within 1%.
3. Water shall be measured by an approved device capable of accurate measurement to one pint.

H. Concrete shall be from a single source for each major pour.

2.03 FORMS

A. Refer to Section 03100 for requirements for concrete forms.

2.04 REINFORCEMENT

A. Refer to Section 032100 for requirements for reinforcement.

2.05 EXPANSION MATERIALS

- A. Verify compatibility of joint filler with sealant specified.
- B. All expansion joints on grade shall be pre-formed non-extruding resilient type, bituminous or bonded cork (ASTM D994 or ASTM D1751).
- C. Other expansion joints may comply with ASTM D1752 – "Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

Manufacturer's certification and material submittal are required.

2.06 CURING, SEALING AND HARDENING COMPOUNDS

A. Liquid Curing and Sealing Compounds – General requirements

1. Curing Compounds: Comply with ASTM C 309, Type 1, Class B.

- a. Non-yellowing formulation where subject to ultra violet light.
 - b. Curing and Sealing Compound: Where indicated, providing curing and sealing formulation with long-lasting finish that is resistant to chemicals, oil, grease, deicing salts, and abrasion.
2. Curing and Hardening Compound: Free of waxes, resins or oils; meet water retention requirements of ASTM C 309; penetrate concrete to change free lime to calcium silicate forming a permanently dense, hard surface.
3. The curing compound shall have test data from an independent laboratory indicating a maximum moisture loss of 0.030 grams per square cm. When applied at a coverage rate of 300 square feet per gallon. Manufacturer's certification is required.
 - a. Provide L&M "dress & Seal 30" or Master Builders "Masterseal 66."
 - b. Dissipating Resin Curing Compound: The compound shall be a dissipating resin type compound, conforming to ASTM C309, Type I, "Kurez DR" by The Euclid Chemical Company or approved equal. The film must chemically break down in a two to four week period after application.
4. Curing compounds shall not be used on any surface against which additional concrete or other cementitious material are to be bonded.

2.07 VAPOR RETARDERS (BARRIERS)

An approved vapor barrier shall be placed as called for in the Contract Documents. Supply a vapor barrier that complies with one of the following:

- A. ASTM E 1745, Class A: A three-ply, nylon- or polyester-cord reinforced, high-density polyethylene sheet; laminated to a nonwoven geotextile fabric, 30 mils (0.76 mm) thick.
- B. ASTM E 1745, Class B: A five-ply nylon- or polyester cord-reinforced, high-density polyethylene sheet; 10 mils (0.25 mm) thick.
- C. ASTM E 1745, Class C: One of the following materials, or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick:
 1. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils (0.25 mm) thick.
 2. Three-ply, nylon- or polyester-cord-reinforced, laminated, high-density polyethylene sheet; 7.8 mils (0.18 mm) thick.
- D. Submittal is required.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the Work. Do not proceed until satisfactory conditions have been corrected.

3.02 CONDUITS, HANGERS, SUPPORTS, ANCHORS, ETC.

- A. The Contractor shall see that all necessary bolts and anchors of all other trades employed on this structure including conduits, sockets, inserts, sleeves, etc., will be placed by their respective trades or shall himself place them to details before concreting a given section of work. He shall see that these items do not interfere with the reinforcement.
- B. No aluminum conduit or product containing aluminum or any other material detrimental to concrete shall be embedded in concrete.
- C. All openings in slabs, beams, columns, and footings, which are not shown on the structural plans, must be approved by the Engineer. The maximum diameter of embedded pipes or conduit shall be 1/3 times the slab or wall thickness. The minimum center-to-center spacing of embedded pipes or conduits shall be three times the outside diameter. For pipes or conduits of different diameters, the minimum edge-to-edge spacing shall be two times the smaller diameter.
- D. All pipes and conduits providing flow able material conveyance which penetrate beams, footings, or walls shall be provided with sleeves of an appropriate size and material to provide movement for expected settlements or deflections.

3.03 PREPARATION

- A. Concrete placing shall not be started until all necessary preparations have been completed and approval has been given. Preparations shall consist of completing all form work involved, placing all reinforcing steel, pipes, conduits, sleeves, hangers, anchors, fastening devices, waterproofing and such other work to be built into the concrete in the section to be poured, and any other preparations herein required for the concreting operations. Free water and any mud or debris shall be removed from forms and excavations to be occupied by concrete. Approved equipment shall be available on the job site for heating and/or protecting the concrete whenever freezing temperatures are likely to occur within the curing period. Ice or chilled water may be required to control concrete temperature in hot weather to below 90 degrees F.
- B. Slabs-on-grade shall be placed on a properly leveled and thoroughly compacted sub grade, equal to 93% maximum dry density. All subsoil's for slabs shall be approved before placing concrete.
- C. Approved equipment shall be provided for heating concrete materials and/or protecting the concrete whenever freezing temperatures are likely to occur within curing period.

3.04 INSTALLATION

- A. Concrete shall be conveyed from the mixer or transporting vehicle to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of materials or displacement of the reinforcing steel and which will avoid rehandling. For ready-mix concrete in an agitator truck, the elapsed time from mixer to placement shall not exceed 1-1/2 hours.
- B. Concrete shall be deposited as nearly as practicable in its final position and shall have the qualities required. Concrete shall be deposited continuously in layers or sections of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause seams or planes of weakness. If sections cannot be placed continuously, proper construction joints shall be provided.

- C. Concrete during and immediately after depositing shall be thoroughly compacted and worked around reinforcing and embedded fixtures and into all parts of forms by means of spades, rods and approved mechanical vibrators.

For thin walls or inaccessible portions, concrete shall be worked into place by vibrating or other approved method: Care shall be taken so as not to work concrete to the point where segregation occurs.

3.05 CONSTRUCTION AND CONTROL JOINTS

- A. All horizontal and vertical construction joints shall be intentionally roughened to a full $\frac{1}{4}$ " \pm amplitude or have a continuous 2"x 4" keyway along the joint at contractor's option.
- B. Provide reinforcing dowels to match the member reinforcing at the joint, unless noted otherwise.
- C. Unless indicated otherwise, slabs-on-grade shall have construction or control joints spaced not to exceed 30 times the slab thickness in any direction. All discontinuous control or construction joints shall be reinforced with two (2) #4 x 48". See structural details. Construction joints shall not exceed a distance of 15'-0" O.C. in any direction.
- D. Control joints shall be installed in slabs-on-grade so the length-to-width ratio of the slab is not more than 1.25:1. Control joints shall be completed within 12 hours of concrete placement. Control joints may be installed by:
1. Saw Cut to a depth of $\frac{1}{4}$ the thickness of the slab.
 2. Tooled joints shall be made to a depth of $\frac{1}{4}$ the thickness of the slab.
- E. Control joints in visually exposed walls, unless noted otherwise (shall line up with masonry and architectural joints, see drawings):
1. Vertical control joints at 10'-0" O.C.
 2. Reinforcing shall be continuous through control and construction joints, unless noted otherwise.
 3. Control joints in foundation walls shall line up with masonry control joints.
- F. Control joints shall be installed in suspended slabs over steel decking by saw cutting along all interior grid lines. Joints centered above the purlins shall be $\frac{3}{4}$ " deep and shall have #4x5'-0" at 16" O.C. reinforcing placed perpendicular to (and centered on) the purlin. Joints centered above the girders shall be $\frac{3}{4}$ " deep and shall have #4x16'0" O.C. reinforcing placed perpendicular to (and centered on) the girder. The #4 bar reinforcing centered above the grid lines shall be in addition to the specified WWF,
which is continuous throughout the suspended slabs over steel decking. Reinforcing shall be placed 1" below the top of the slab.

3.06 FINISHING

- A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding $\frac{1}{4}$ " in height rubbed down or chipped off.

- B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or surfaces that are covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp proofing, painting or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.
- C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment, not later than one day after form removal. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
- E. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, terrazzo, stone and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to a tolerance not exceeding 1/2" in 10' when tested with a 10' straightedge. Slope surfaces uniformly to drains where required. After leveling; roughen surface before final set, with stiff brushes, brooms or rakes.
- F. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, and as otherwise indicated. After screening, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance not exceeding 1/4" in 10' when tested with a 10' straightedge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth granular texture.
- G. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, paint or other thin film finish coating system. After floating, begin final trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge. Grind smooth surface defects, which would telegraph through applied floor covering system.
- H. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect and Owner's Representative before application. See Section 02528 – Concrete Paving and Curbs.
- I. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floors where indicated. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water, and apply in 3 coats; first coat, 1/3-strength; second coat, 1/2-strength; third coat,

2/3-strength. Evenly apply each coat and allow 24 hours for drying between coats. Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions. After final coat of chemical hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.07 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect. Cut out honeycomb, rock pockets, voids over ¼" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brushcoat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
- B. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repair of Formed Surfaces: Remove and replace concrete having defective surface if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.
- D. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- E. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.
- F. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
- G. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
- H. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.
- I Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least ¾" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same material to provide concrete of same type or class as original

concrete. Place, compact and finish to blend with adjacent finish concrete. Cure in same manner as adjacent concrete.

- J. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry pack, consisting of one-part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact-dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours. Use epoxy-based mortar for structural repairs, where directed by the testing laboratory.
- K. Repair methods not specified above may be used, subject to acceptance of Architect.

3.08 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- B. Curing Methods: Perform curing of concrete by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified.
- C. Provide moisture curing by following methods:
1. Keep concrete surface continuously wet by covering with water.
 2. Continuous water-fog spray.
 3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
- D. Provide moisture-cover as follows:
1. Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- E. Provide curing compound to slabs as follows:
1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

2. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, damp proofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to Architect.
- F. Curing Formed Surfaces: Cure formed concrete surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- G. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing compound. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

3.09 MISCELLANEOUS

- A. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

END OF SECTION 32 13 73.19

SECTION 32 16 13 – CONCRETE CURBS AND CURB & GUTTER

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This Section specifies the requirements for providing, placing, curing, and protecting Portland cement curbs, and combination curbs and gutters, constructed on a prepared subgrade.

1.2 QUALITY ASSURANCE

- A. Reference Standards Applicable to this Section

1. ACI: American Concrete Institute
 - a. 316R: Recommendations for Construction of Concrete Pavements and Concrete Bases.
2. ASTM: American Society for Testing and Materials
 - a. A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (with Supplement + S1).
 - b. C 150: Specification for Portland Cement Type I or Type II.
 - c. C 309: Specification for Liquid Membrane - Forming Compounds for Curing Concrete.
 - d. D 1565: Specifications for Flexible Cellular Materials Vinyl Chloride Polymers and Copolymers (Closed Cell).
 - e. D 1751: Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient bituminous Types).
 - f. D 1752: Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - g. D 3405: Specification for Joint Sealants, Hot-Poured, for Portland Cement Concrete Pavement.
3. FS: Federal Specifications and Standards
 - a. TT-P-86: Paint, Red-Lead-Base, Ready-Mixed.

- B. Finishing Tolerance

The top surface of curbs and combination curbs and gutters shall have a Class A tolerance as specified in ACI 316 R, Chapter 12.5.

1.3 SUBMITTALS

- A. In accordance with Section 013300 – Submittal Procedures, the following shall be submitted:
1. Reinforcement Materials
 - a. As required in Section 032100 - Concrete Reinforcement of these Specifications.
 2. Concrete Materials
 - a. As required in Sections 321373.19 - Cast-in-Place Concrete of these Specifications.

1.4 EXTENDED WARRANTY

- A. Manufacturer of joint sealant shall provide at least a 1-year written warranty against material degradation and failure and water and foreign matter infiltration through the joint from the time of written acceptance of the Work. This warranty shall not limit LIT rights or remedies as may otherwise be afforded under law or statute.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Forms
- Either wood or metal, of the size and shape necessary for forming the item, straight and free of warp.
- B. Reinforcing Steel Bars
- As specified in Section 032100 - Concrete Reinforcement of these Specifications.
- C. Dowel Bars
- Smooth, ASTM A 615 + S1, Grade 60, new billet steel, unbonded ends painted with red-lead-base paint, FS TT-P-86, Type I and coated with a water-resistant lubricant immediately prior to placement of concrete in which unbonded ends of bars are to be embedded.
- D. Dowel Bar Expansion Caps
- PVC or plastic cap, slightly larger than dowel bar, closed end, a minimum of 6 in. long, with 1-1/2 in. long compressible insert.
- E. Concrete
- Class 3000, as specified in Section 321373.19 – Cast-in-Place Concrete of these Specifications.
- F. Membrane Forming Curing Compound
- ASTM C 309, Type 2, unless otherwise directed.

G. Joint Materials

1. Preformed Expansion Joint Filler: Nonextruding and resilient bituminous type, ASTM D 1751.
2. Joint Sealing Material: See Section 321373 of these Specifications.

H. Form Coating

Commercial formulation form-coating compound that will not bond with, stain nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

- A. Prepared subgrade shall be inspected for unstable or unsuitable areas and need for additional compaction. Notify the Engineer in writing of such deficiencies. Do not begin curb construction until all such deficiencies have been corrected.
- B. Loose and foreign material shall be removed from the compacted subgrade immediately prior to placing concrete, and subgrade shall be uniformly dampened.

3.2 SETTING FORMS

- A. Forms shall be set to the line and grade indicated and shall be securely staked to maintain set position during depositing and curing of concrete. The inside form shall be rigidly attached to the outside form.
- B. Forms shall be set in sufficient quantity to allow continuous progress of concrete placement and to ensure that forms shall remain in place not less than 24 hours.
- C. Forms shall be cleaned after each use and coated with an approved form release agent prior to each use.

3.3 INSTALLATION OF JOINTS, REINFORCEMENT, AND SEALANT

- A. Reinforcement shall be installed as indicated on the Drawings and as specified in Section 032100 - Concrete Reinforcement of these Specifications. Joints shall be installed where indicated on the Drawings and in accordance with Section 321319 – Concrete Pavement Joints of these Specifications.
- B. Sealant manufacturer's instructions and procedures shall be followed so as not to invalidate the warranty.

3.4 PLACING AND FINISHING CONCRETE

- A. Concrete shall be placed and finished as specified in Section 321373.19 - Cast-in-Place Concrete of these Specifications, and ACI 316 R, Chapters 10 and 12.5.
- B. After concrete has been struck off and has sufficiently set, the exposed surfaces shall be worked with a wood float. The exposed edges shall be rounded using an edging tool.

- C. After form removal, the surfaces of the curb or combination curb and gutter shall be plastered with a mortar consisting of one-part Portland Cement and two parts fine aggregate. Mortar shall be applied with a template constructed to the shape and dimensions of the item to be plastered. All exposed surfaces shall be brushed to a uniform smooth texture.

3.5 CURING AND PROTECTING CONCRETE

- A. Concrete shall be cured in accordance with the recommendations of ACI 316 R, Chapter 11, using the membrane curing method and materials.
- B. Protection as recommended in ACI 316 R; Chapter 11 shall be provided until written acceptance by the Engineer.

END OF SECTION 32 16 13

SECTION 33 05 16 – UTILITY STRUCTURES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Excavation and backfill.
- B. Cast-in place concrete structures.
- C. Precast concrete structures.
- D. Metal components.

1.2 RELATED SECTIONS

- A. Concrete formwork, concrete reinforcement, cast-in-place concrete, Portland cement concrete, concrete repair and finishing, and precast concrete are specified in the various Sections under Division 3 - Concrete.
- B. Interior trench drains and gratings for interior uses are specified in Section 05 50 00 - Metal Fabrication.
- C. Duct banks are specified in Section 20 50 16 - Underground Ductwork and Structures for Facility Services.

1.3 MEASUREMENT AND PAYMENT

- A. General: Measurement and payment for utility structures will be either by the lump-sum method or by the unit-price method as determined by the listing of the bid item for utility structures indicated in the Bid Schedule of the Bid Form.
- B. Lump Sum: If the Bid Schedule indicates a lump sum for utility structures, the lump-sum method of measurement and payment will be in accordance with Section 01 20 00 - Price and Payment Procedures, Article 1.03.
- C. Unit Price: If the Bid Schedule indicates a unit price for utility structures, the unit-price method of measurement and payment will be as follows:
 - 1. Measurement:
 - a. Cast-in-place concrete and precast concrete units or structures and metal curb-and-gutter inlets will be measured for payment by the individual unit (each), installed in place. Each different type and size of concrete unit or structure will be measured separately for payment.
 - b. Manhole covers and frames, grates and frames, pipe inlets and outlets, manhole steps, ladders, miscellaneous metal, reinforcing steel, and grounding will not be measured separately for payment, but will be included as part of the utility structure to which it is attached or embedded.

- c. Excavation and backfill for utility structures will be measured separately for payment as specified in Section 31 00 00 - Earthwork, as applicable.
2. Payment:
- a. Utility structures will be paid for at the indicated Contract unit prices for the computed quantities as determined by the measurement method specified in Article 1.03.C.1, herein.

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM):
- 1. ASTM A36/A36M Specification for Structural Steel
 - 2. ASTM A48 Specification for Gray Iron Castings
 - 3. ASTM A108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
 - 4. ASTM A123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 5. ASTM A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 6. ASTM A536 Specifications for Ductile Iron Castings
 - 7. ASTM B3 Specification for Soft or Annealed Copper Wire
 - 8. ASTM B26/B26M Specification for Aluminum-Alloy Sand Castings
 - 9. ASTM C33 Specification for Concrete Aggregates
 - 10. ASTM C150 Specification for Portland Cement
 - 11. ASTM C260 Specification for Air-Entraining Admixtures for Concrete
 - 12. ASTM C270 Specification for Mortar for Unit Masonry
 - 13. ASTM C478 Specification for Precast Reinforced Concrete Manhole Sections
 - 14. ASTM C618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
 - 15. ASTM C789 Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers

16. ASTM C850 Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 feet of Cover Subjected to Highway Loadings
17. ASTM C858 Specification for Underground Precast Concrete Utility Structures
18. ASTM C891 Practice for Installation of Underground Precast Concrete Utility Structures

B. Underwriters Laboratories Inc. (UL):

1. UL 467 Grounding and Bonding Equipment

1.5 SUBMITTALS

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Shop Drawings: When not indicated on the Contract Drawings in sufficient detail or definition, submit detailed drawings of cast-in-place and precast concrete utility structures and related metal work.
- C. Product Data: Submit manufacturers' product data for standard manufactured precast concrete utility boxes and structures and for metal gratings and covers and other, related miscellaneous metal items.
- D. Certification: Submit certification or other acceptable evidence that covers and grates to be provided for roadways and parking areas meet proof-testing requirements for H2O and HS2O loadings in accordance with TXDOT's Bridge Design Specifications Manual.

PART 2 – PRODUCTS

2.1 CAST-IN-PLACE CONCRETE STRUCTURES

- A. Materials: Comply with requirements of Section 32 13 13 - Portland Cement Concrete, except as specified otherwise herein.
 1. Portland Cement: ASTM C150, Type II, low alkali.
 2. Cementitious Admixture: Provide fly ash or pozzolan conforming with ASTM C618, Class F or N, not to exceed 15 percent by weight of the cement content.
 3. Aggregates: ASTM C33, fine aggregate and Size Nos. 56 or 57 (1-inch maximum size) coarse aggregate.
- B. Mix Design: Obtain design of concrete mix as specified in Section 32 13 13 - Portland Cement Concrete, and incorporate the following requirements:
 1. Concrete Strength: Class 4000 minimum in accordance with Table 03305-A of Section 32 13 13 - Portland Cement Concrete, except that electrical structures, such as vaults, pull boxes, and concrete for ductbanks, shall be Class 3000.

2. Maximum water-cement plus pozzolan ratio: 0.45.
3. Maximum slump: 4 inches.

2.2 PRECAST CONCRETE STRUCTURES

- A. General: The Contractor may provide precast concrete structures that conform to the general configuration, capacities, and inverts indicated.
- B. Fabrication Standards: Comply with requirements of Section 03 40 00 - Precast Concrete, and ASTM C478, ASTM C789, ASTM C850, and ASTM C858, as applicable, and applicable manufacturers' standards.
- C. Materials: Comply with requirements of Section 03 21 00 - Concrete Reinforcing, Section 32 13 13 - Portland Cement Concrete, and Section 03 40 00 - Precast Concrete, except as specified otherwise herein. Provide fine and coarse aggregates conforming to ASTM C33, in size commensurate with structure and reinforcement clearances.
- D. Portland Cement Concrete: Class 4000 minimum in accordance with Table 03305-A of Section 32 13 13 - Portland Cement Concrete. Concrete may be polymer or latex modified to achieve higher strengths and denser concrete. Concrete shall not deteriorate from chemical attack of sanitary waste.
 1. Concrete for electrical utility structures shall be Class 3000.
- E. Precast Covers: Precast covers shall have the utility identification, such as "PG&E Gas Valve," stamped into the cover.
- F. Quality Control: In accordance with Section 01 45 00 - Quality Control, the Contractor shall perform such inspections and tests as required to verify compliance with these Specifications.

2.3 METAL COVERS, GRATES, AND INLETS

- A. Ferrous Castings:
 1. Metal used in manufacture of castings shall conform to ASTM A48, Class 35B for Gray Iron, or ASTM A536, Grade 65-45-12 for Ductile Iron.
 2. Castings shall be of uniform quality, free from blowholes, shrinkage, distortion or other defects. Castings shall be smooth and cleaned by shotblasting.
 3. Minimum tensile strength shall be 35,000 psi.
 4. Castings shall be manufactured true to pattern; component parts shall fit together in a satisfactory manner. Round frames and covers shall have continuously machined bearing surfaces to prevent rocking and rattling.
 5. Where castings will be subjected to loads of H₂O or greater, as indicated, provide ductile iron castings.

- B. Aluminum Castings: Where required to reduce weights of larger covers for ease of handling, such covers may be manufactured of aluminum castings conforming to ASTM B26/B26M, Alloy No. 713.0. Minimum tensile strength shall be 32,000 psi.
- C. Manhole Covers: Provide cast, manufactured manhole covers and frames with heavy-duty solid cover (lid) or vented cover (lid) as indicated. Covers shall be embossed or engraved with nonslip diamond or square cross-hatched pattern. Provide covers with embossed or engraved word identification, as indicated or appropriate, for the enclosed or underground utility.
- D. Grates:
 - 1. Cast Ferrous Grates: Grates for area drains and catch basins shall be heavy-duty, bicycle safe inlet grates and frames of size and configuration indicated. Grates in roadways and parking areas shall withstand H20 loadings when proof-tested in accordance with TXDOT's Bridge Design Specifications Manual.
 - 2. Bar-Type Steel Grates: Refer to Section 05 50 00 - Metal Fabrications, for requirements. Bar-type steel gratings will be permitted only in areas where vehicular traffic will not be encountered.
- E. Curb and Gutter Inlets: Provide cast, manufactured curb inlet frame, grate, and curb box of size and configuration indicated. Curb and gutter inlets shall conform to the contour and profile of the concrete curb and gutter. Grates shall be heavy-duty and bicycle-safe and shall withstand H20.
- F. Cast Iron Manhole Steps: Provide cast, manufactured manhole steps with cross-hatched treads and with anchor configuration appropriate for cast-in-place concrete or precast concrete as indicated. Provide steps for installation 12 inches on center in vertical alignment.

2.4 MISCELLANEOUS METAL

- A. Requirements: Provide channel inserts, pulling eyes, ladders, and electrical grounding rods for electrical manholes and pull boxes as indicated.
- B. Steel Materials: Standard structural sections, shapes, plates, bars, and rods, as indicated, conforming with ASTM A36/A36M. Bars conforming with ASTM 108 will be acceptable.
- C. Anchors and Bolts: Conform with requirements of Section 05 50 00 - Metal Fabrications, as applicable. Bolts and studs, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A153.
- D. Ladders: Provide standard-manufactured or custom-fabricated steel ladders as required to meet the conditions indicated. Steel ladders shall be hot-dip galvanized after fabrication.
- E. Grounding and Bonding Materials: Conform with UL 467 and the following requirements:
 - 1. Grounding Rods: Medium carbon steel core, copper-clad by the molten weld casting process, 3/4-inch diameter by 10 feet long in size.
 - 2. Bare Conductors: ASTM B3, No. 1/0 AWG, Class B stranded, annealed copper conductor.

- F. Fabrication: Form and fabricate the work as indicated. Include anchors, fasteners, and accessories to anchor and secure the work in place.
- G. Galvanizing: All ferrous metal items shall be galvanized after fabrication by the hot-dip process in accordance with ASTM A123. Weight of the zinc coating shall conform with the requirements specified under "Weight of Coating" in ASTM A123.

2.5 MORTAR

- A. Cement mortar for the sealing of openings for pipe penetrations, for cementing of joints of component parts of precast structures, for providing of flow characteristics for the bottoms of drainage structures, and other features as indicated shall conform with the Texas Building Code.
- B. Mortar shall comply with applicable requirements of ASTM C270, including measurement, mixing, proportioning, and water retention. Ten percent by volume of the cement content of the mortar shall be fly ash or pozzolanic material conforming with ASTM C618.
- C. Use mortar within 90 minutes after mixing. Discard mortar that has been mixed longer or that has begun to set. Re-tempering of mortar will not be permitted.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Requirements: Construct manholes, junction chambers, catch basins, curb and gutter inlets, trench drains, culverts, headwalls, wingwalls, pull boxes, utility boxes and vaults, and related utility structures in connection with the installation of pipe, conduits, ductbanks, and utility trenches, as indicated.
- B. Excavation and Backfill: Provide excavation, prepared subgrade and aggregate base, and backfill as specified in Section 31 00 00 - Earthwork, Section 33 05 28 - Trenching and Backfilling for Utilities, Section 32 11 17 - Aggregate Subbase Courses, and Section 32 11 23 - Aggregate Base Course, as indicated.
- C. Cast-in-Place Concrete Structures: Provide formwork, steel reinforcement, and concrete in accordance with applicable requirements of Section 03 11 00 - Concrete Forming, Section 03 21 00 - Concrete Reinforcing, and Section 321373.19 - Cast-In-Place Concrete.
- D. Precast Concrete Structures: Install as indicated. Comply with applicable requirements of ASTM C891. Provide such appurtenances and installation accessories, including cement mortar and sealants, as required for a complete installation.
- E. Metal Components: Install manhole covers, grates and frames, curb and gutter inlets, metal steps, ladders, channel inserts, pulling eyes, and electrical grounding rods as indicated and in accordance with the respective manufacturer's instructions. Covers and grates in roadways, parking areas, and concrete walks shall be installed flush with adjacent, abutting pavement.

3.2 FIELD QUALITY CONTROL

- A. The Contractor shall perform slump tests and strength tests of cast-in-place structures in accordance with the requirements specified in Section 32 13 13 - Portland Cement Concrete.
- B. Acceptance of cast-in-place structures will be in accordance with Section 32 13 13, Portland Cement Concrete.

END OF SECTION 33 05 16

SECTION 33 05 28 – TRENCHING AND BACKFILLING FOR UTILITIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices
 - 1. No additional payment will be made for trench excavation, embedment and backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.
 - 2. When Project Manager directs Contractor to over excavate trench bottom, Contractor will be paid by unit price bid per linear foot under bid item - 6-inches Over Excavation of Trench Bottom.
 - a. No payment will be paid if Project Manager does not direct Contractor to over excavate trench bottom.
 - b. No over excavation will be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01578 - Control of Ground and Surface Water.
 - 3. No additional payment will be made for performing Critical Location exploratory excavation. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price

1.03 DEFINITIONS

- A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Drawings, or foundation backfill material placed and compacted in over-excavations.
- B. Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
- C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.
- D. Initial Backfill: Portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to level line 12-inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
- E. Pipe Embedment: Portion of trench backfill that consists of bedding, haunching and

- initial backfill.
- F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.
- G. Unsuitable Material: Unsuitable soil materials are the following:
1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.
 3. Materials that contain large clods, aggregates, stones greater than 4-inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime, fly ash, or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.
- I. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.
- J. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.
- K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.
- L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D 2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.
- M. Trench Conditions are defined with regard to stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
 2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.

- a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
- b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.
- 3. Unstable Trench: Unstable trench conditions exist in pipe embedment zone if ground water inflow or high-water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.
- N. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.
- O. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.
- P. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings and backfilled with foundation bedding.
- Q. Foundation Bedding: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation bedding is placed and compacted as backfill to provide stable support for bedding. Foundation bedding materials may include concrete seal slabs.
- R. Trench Safety Systems include both protective systems and shoring systems as defined in Section 02260 - Trench Safety Systems.
- S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.
- T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.
- U. Special Shoring: Shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements, for locations identified on Drawings.
- V. Vacuum Excavation: An excavation technique performed by an experienced subcontractor in which water or air jetting is used to slough off and vacuum away soil.
- W. Large Diameter Water Line (LDWL): Water line that is 24-inches in diameter or larger. X. Emergency Action Plan (EAP): The EAP document should include a discussion of procedures for timely and reliable detection, classification (level of emergency) and response procedure to a potential emergency condition associated with a large diameter

- Y. water line.
Subsurface Utility Exploration (SUE): Non-destructive excavation, unless otherwise approved by project manager.

1.04 REFERENCES

- A. ASTM A 798 – Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.
- B. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipelines.
- C. ASTM C 891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures
- D. ASTM C 1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
- E. ASTM C 1675 - Standard Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
- F. ASTM C 1821 - Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures
- G. ASTM D 558 - Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures.
- H. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)).
- I. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- J. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- K. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classifications System).
- L. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- M. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- N. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- O. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.
- P. TxDOT Tex-110-E - Particle Size Analysis of Soils.
- Q. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

1.05 SCHEDULING

- A. Schedule work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.
- B. For proposed utility adjacent to or across existing LDWL:
 - 1. Conduct a meeting between contractor, Drinking Water Operations and Utility Maintenance Branch prior to beginning excavation to coordinate the EAP in the event a water line shut down becomes necessary.
 - 2. Notify Drinking Water Operations a minimum of 1 week prior to beginning construction activities.
 - 3. Notify Drinking Water Operations a minimum of 48 hours prior to beginning SUE work near LDWL.
 - 4. Unless otherwise approved by City Engineer, perform construction activities between 7 AM and 7 PM, Monday through Friday. No work permitted around a LDWL on weekends or City Holiday.
 - 5. A City Inspector must be present during SUE or construction activities occurring within four feet or one diameter of the LDWL, whichever is greater, from a LDWL or appurtenance.

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit planned typical method of excavation, backfill placement and compaction including:
 - 1. Trench widths.
 - 2. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction.
 - 3. Procedures for assuring compaction against undisturbed soil when pre-manufactured trench safety systems are proposed.
- C. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.
- D. Submit trench excavation safety program in accordance with requirements of Section 02260 - Trench Safety System. Include designs for special shoring meeting requirements defined in Paragraph 1.08, Special Shoring Design Requirements contained herein.
- E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.
- F. Submit 11-inch by 17-inch or 12-inch by 18-inch copy of Drawing with plotted utility or obstruction location titled "Critical Location Report" to Project Manager.

- G. For installation of proposed utility adjacent to or across existing LDWL, prepare and submit the following to Drinking Water Operations prior to beginning construction activities. Obtain approval from Drinking Water Operations prior to commencing prelocate or utility work near LDWL.
1. Trench details, shoring system designs, installation sequences, and flowable fill mix designs.
 2. Emergency Action Plan (EAP) to address contingency plans in the event of damage to or failure of LDWL. Include the following:
 - a. Contact personnel and agencies including primary and secondary telephone numbers.
 - b. Contractor's hierarchy of responsible personnel.
 - c. Traffic control measures.
 - d. Identification of resources to be available on or near project site in event of damage to or failure of LDWL.

1.07 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.
- B. Perform backfill material source qualification testing in accordance with requirements of Section 02320 - Utility Backfill Materials.

1.08 SPECIAL SHORING DESIGN REQUIREMENTS

- A. Have special shoring designed or selected by Contractor's Professional Engineer to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a premanufactured system selected by Contractor's Professional Engineer to meet project site requirements based on manufacturer's standard design.

PART 2 - PRODUCTS

2.01 EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.
- B. Use only hand-operated tamping equipment until minimum cover of 12-inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.
- C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.

- D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.08, Special Shoring Design Requirements.

2.02 MATERIAL CLASSIFICATIONS

- A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials and Section 02321 – Cement Stabilized Sand.
- B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315 - Concrete for Utility Construction.
- C. Geotextile (Filter Fabric): Conform to requirements of Section 02621 Geotextile.
- D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.

PART 3 - EXECUTION

3.01 STANDARD PRACTICE

- A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.
- B. Install rigid pipe to conform to standard practice described in ASTM C 12, C 1479, or C 1675 as applicable, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

3.02 PREPARATION

- A. Establish traffic control to conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by Work, and are considered hazardous to traffic movements.
- B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02260 - Trench Safety Systems.
- C. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.
- D. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02221 - Removing Existing Pavements, Structures, Wood and Demolition Debris, as applicable.
- E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01578 - Control of Ground and Surface Water. Provide stable trench to allow installation in accordance with Specifications.
- F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 - Field Surveying.

3.03 CRITICAL LOCATION INVESTIGATION

- A. Horizontal and vertical location of various underground lines shown on Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations. Unless otherwise approved by Project Manager, at Critical Locations shown on Drawings, perform vacuum excavation to field verify horizontal and vertical locations of such lines within a zone 2 feet vertically and 4 feet horizontally of proposed work exclude water jetting at PCCP water line.
1. Verify location of existing utilities minimum of 7 working days in advance of pipe laying activities based on daily pipe laying rate or prior to beginning installation of auger pit or tunnel shaft. Use extreme caution and care when uncovering utilities designated by Critical Locate.
 2. Notify Project Manager in writing immediately upon identification of obstruction. In event of failure to identify obstruction in minimum of 7 days, Contractor will not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until 7 days has passed from time Project Manager is notified of obstruction.
- B. Notify involved utility companies of date and time that investigation excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Project Manager with 48 hours notice prior to field excavation or related work.
- C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot on 12-inch by 18-inch copy of Drawings. For large diameter water lines, submit to Project Manager for approval, horizontal and vertical alignment dimensions for connections to existing lines, tied into project baseline, signed and sealed by R.P.L.S.
- D. LDWL Prelocate Requirements:
1. Field-locate LDWL, appurtenances and laterals connected directly to LDWL through use of non-probing method such as a vacuum truck (non-water jetting method) at no greater than 50-foot intervals. Locate upstream and downstream of proposed work or utility installation.
 2. Record crown and side of LDWL adjacent to proposed work or utility installation. Record LDWL locations horizontally and vertically using same coordinate system employed on proposed utility drawings.
 3. Tie horizontal and vertical coordinates into project baseline. Submit recordings performed by R.P.L.S to City a minimum of 14 days prior to mobilizing to site.

3.04 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.
- B. Protect and support above-grade and below-grade utilities which are to remain.

- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.
- D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches.
Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, re-compact, and pave those areas at no additional cost to City.
- E. Contingency plans for proposed work or utility installation adjacent to or across a LDWL:
 - 1. Conduct on-site emergency drill prior to commencing proposed utility installation, and at three month intervals to assure EAP is current.
 - 2. In the event a LDWL shut down becomes necessary, secure site and provide assistance to City personnel to access pipe and isolation valves as needed.

3.05 EXCAVATION

- A. Except as otherwise specified or shown on Drawings, install underground utilities in open cut trenches with vertical sides.
- B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.
- C. Determine trench excavation widths using following schedule as related to pipe outside diameter (O.D.). Excavate trench so that pipe is centered in trench.

Nominal Pipe Size, Inches	Minimum Trench Width, Inches
Less than 18	O.D. + 18
18 to 30	O.D. + 24
36 to 42	O.D. + 36
Greater than 42	O.D. + 48

Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

- D. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.
- E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding.
- F. Shoring of Trench Walls.
 - 1. Install Special Shoring in advance of trench excavation or simultaneously with

- trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.
2. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.
 3. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by Project Manager. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.
 4. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
 5. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.
- G. Use of Trench Shields. When trench shield (trench box) is used as worker safety device, the following requirements apply:
1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.
 2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re- compact after shield is moved if soil is disturbed.
 3. When required, place, spread, and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.
 4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.
 5. Conform to applicable Government regulations.
- H. Voids under paving area outside shield caused by Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate supports.
- I. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.

- J. Coordinate excavation within 15 feet of pipeline with company's representative. Support pipeline with methods agreed to by pipeline company's representative. Use small, rubber-tired excavator, such as backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within 1 foot of Pipeline Company's line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by Pipeline Company's representative.
- K. When, during excavation to uncover pipeline company's pipelines, screwed collar or an oxy-acetylene weld is exposed, immediately notify Project Manager. Provide supports for collar or welds. Discuss with Pipeline Company's representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.
- L. Excavation and shoring requirements for proposed work or utility installation adjacent to or across a LDWL:
1. Identify LDWL area in field and barricade off from construction activities. Allow no construction related activities including, but not limited to, loading of dump trucks and material staging or storage, on top of LDWL.
 2. Employ a groundwater control system when performing excavation activities within ten feet of LDWL to:
 - a. Effectively reduce hydrostatic pressure affecting excavations,
 - b. Develop substantially dry and stable subgrade for subsequent construction operations,
 - c. Prevent loss of fines, seepage, boils, quick condition or softening of foundation strata, and
 - d. Maintain stability of sides and bottom of excavations.
 3. When edge of proposed trench or shoring is within a distance equal to one diameter of LDWL from outside of wall of LDWL, valve or appurtenance:
 - a. Maintain minimum of four (4) feet horizontal clearance and minimum of two (2) feet vertical clearance between proposed utility and LDWL.
 - b. Auger Construction
 - 1) Maintain minimum of four (4) feet horizontal clearance between proposed utility and LDWL.
 - 2) Dry auger method required when auger hole is 12-inches and larger in diameter.

- c. Open Cut Construction and Auger pits
 - 1) Perform hand excavation when within four (4) feet of LDWL.
 - 2) Employ hydraulic or pneumatic shoring system. Do not use vibratory or impact driven shoring or piling.
 - 3) Expose no more than 30-feet of trench prior to backfilling.
 - 4) A maximum of one (1) foot of vertical trench shall be un-braced at a time to maintain constant pressure on face of excavated soil.
 - 5) Upon removal of shoring system, inject flowable fill into void space left behind by shoring system. Comply with Standard Specification 02322 - Flowable Fill.
- d. When edge of utility excavation is greater than one diameter of LDWL from outside wall of LDWL, use a shielding system as required by Project Manager and proposed utility standards and practices.

3.06 HANDLING EXCAVATED MATERIALS

- A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section 02320 - Utility Backfill Materials. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.
- B. When required, provide additional backfill material conforming to requirements of Section 02320 - Utility Backfill Materials.
- C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect backfill material to be used on site. Maintain site conditions in accordance with Section 01504 - Temporary Facilities and Controls. Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

3.07 TRENCH FOUNDATION

- A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.
- B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional 6-inches with approval by Project Manager. Place non-woven geotextile fabric and then compact 12-inches of crushed stone in one lift on top of fabric. Compact crushed stone with four passes of vibratory-type compaction equipment.
- C. Perform over excavation, when directed by Project Manager, in accordance with Paragraph 3.07.B above. Removal of unstable or unsuitable material may be required if approved by Project Manager;
 - 1. Even though Contractor has not determined material to be unsuitable, or

2. If unstable trench bottom is encountered and an adequate ground water control system is installed and operating according to Section 01578 - Control of Ground and Surface Water.

- D. Place trench dams in Class I foundations in line segments longer than 100 feet between manholes and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.08 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

- A. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.
- B. Place embedment including bedding, haunching, and initial backfill as shown on Drawings.
- C. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.
- D. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.
- E. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.
- F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.
- G. Place haunching material manually around pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sand bags or other suitable means.
- H. Place electrical conduit, if used, directly on foundation without bedding.
- I. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.
- J. For water lines construction embedment, use bank run sand, concrete sand, gem sand, pea gravel, or crushed limestone as specified in Section 02320 - Utility Backfill Material. Adhere to the following subparagraph numbers 1 and 2.

1. Class I, II and III Embedment Materials:
 - a. Maximum 6-inches compacted lift thickness.

- b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be within -3 percent to +5 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Project Manager.
 - 2. Cement Stabilized Sand (where required for special installations):
 - a. Maximum 6-inches compacted thickness.
 - b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be on dry side of optimum as determined according to ASTM D 698 but sufficient for effective hydration.
- K. For Sanitary Sewers adhere to subparagraph number 1 and 2. For Storm Sewers provide cement stabilized sand per paragraph 2. This provision does not apply to Storm Sewers constructed of HDPE pipe installed under pavement.
 - 1. Class I Embedment Materials.
 - a. Maximum 6-inches compacted lift thickness.
 - b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.
 - c. Moisture content as determined by Contractor for effective compaction without softening soil of trench bottom, foundation or trench walls.
 - 2. Class II Embedment and Cement Stabilized Sand.
 - a. Maximum 6-inches compacted thickness.
 - b. Compaction by methods determined by Contractor to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.
 - c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.
- L. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill pipe embedment as specified in Section 02322 - Flowable Fill.

- M. Place trench dams in Class I embedment in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.09 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.
- B. For water lines, under pavement and to within one foot back of curb, use backfill materials described below:
1. For water lines 20-inches in diameter and smaller, use bank run sand or select backfill materials up to pavement base or subgrade.
 2. For water lines 24-inches in diameter and larger, backfill with suitable on-site material (random backfill) up to 12-inches below pavement base or subgrade. Place minimum of 12-inches of select backfill below pavement base or subgrade.
- C. For sewer pipes (Storm and Sanitary), use backfill materials described by trench limits. For "trench zone backfill" under pavement and to within one foot back of curb, use cement stabilized sand for pipes of nominal sizes 36-inches in diameter and smaller to level 12 inches below the pavement. For sewer pipes 42-inches in diameter and larger, under pavement or natural ground, backfill from 12-inches above top of pipe to 120 inches below pavement with suitable on-site material or select backfill. Use select backfill for rigid pavements or flexible base material for asphalt pavements for 12-inch backfill directly under pavement. For backfill materials reference Section 02320 - Utility Backfill Materials. This provision does not apply where a Storm Sewer is constructed of any flexible pipe product.
- D. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill as specified in Section 02322 - Flowable Fill. For Storm Sewers constructed of any flexible pipe product and not installed under pavement provide cement stabilized sand.
- E. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting 1.5-feet or more above crown of pipe. Remove trench supports within 5-feet from ground surface.
- F. Unless otherwise shown on Drawings. Use one of the following trench zone backfills under pavement and to within one foot of edge of pavement. Place trench zone backfill in lifts and compact. Fully compact each lift before placement of next lift.
1. Class I, II, or III or combination thereof:
 - a. Place in maximum 12-inch thick loose layers.
 - b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 698.

- c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless otherwise approved by Project Manager.
 - 2. Cement-Stabilized Sand:
 - a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but do not exceed 12-inches.
 - b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 558.
 - c. Moisture content on dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.
 - 3. Class IVA and IVB (Clay Soils):
 - a. Place in maximum 8-inch thick loose lifts.
 - b. Compaction by vibratory Sheepfoot roller to minimum of 95 percent of maximum dry density determined according to ASTM D 698.
 - c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless approved by Project Manager.
- G. Unless otherwise shown on Drawings, for trench excavations not under pavement, random backfill of suitable material may be used in trench zone. This provision does not apply to flexible pipe used for storm sewers.
 - 1. Fat clays (CH) may be used as trench zone backfill outside paved areas at Contractor's option. When required density is not achieved, at any additional cost to City, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements, or use different suitable material.
 - 2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.
 - 3. Compact to minimum of 90 percent of maximum dry density determined according to ASTM D 698.
 - 4. Moisture content as necessary to achieve density.
- H. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

- A. Below paved areas or where shown on Drawings, encapsulate manhole with cement stabilized sand; minimum of 2 foot below base, minimum 2 foot around walls, up to pavement

subgrade or natural ground. Compact in accordance with Paragraph 3.09.F.2 of this Section.

- B. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on Drawings. Deposit backfill in uniform layers and compact each layer as specified. Maintain backfill material at no less than 2 percent below nor more than 5 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698.
- C. For LDWL projects, encapsulate manhole with cement stabilized sand; minimum of 1 foot below base, minimum of 2 feet around walls, up to within 12-inches of pavement subgrade or natural ground. For manholes over water line, extend encapsulation to bottom of trench. Compact in accordance with Paragraph 3.09 F.2 of this Section.

3.11 FIELD QUALITY CONTROL

- A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.
- B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to City.
- C. Tests will be performed on minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity, or when requested by Project Manager.
- D. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement- stabilized sand in accordance with ASTM D 558. Perform additional moisture-density relationship tests once a month or whenever there is noticeable change in material gradation or plasticity.
- E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at following frequencies and conditions.
 - 1. For open cut construction projects and auger pits: Unless otherwise approved by Project Manager, successful compaction to be measured by one test per 40 linear feet measured along pipe for compacted embedment and two tests per 40 linear feet measured along pipe for compacted trench zone backfill material. Length of auger pits to be measured to arrive at 40 linear feet.
 - 2. A minimum of three density tests for each full shift of Work.
 - 3. Density tests will be distributed among placement areas. Placement areas are: foundation, outer bedding, haunching, initial backfill and trench zone.
 - 4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.

5. Density tests may be performed at various depths below fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
 6. Two verification tests will be performed adjacent to in-place tests showing density less than acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
 7. Recompacted placement will be retested at same frequency as first test series, including verification tests.
 8. Identify elevation of test with respect to natural ground or pavement.
- F. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.
- G. Acceptability of crushed rock compaction will be determined by inspection.

3.12 DISPOSAL OF EXCESS MATERIAL

- A. Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION 33 05 28

SECTION 33 11 13 – WATER LINES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Requirements for installation of both small diameter water lines and large diameter water lines.
 - 1. When specifications for large diameter water lines differ from those for small diameter water lines, large diameter specifications will govern for large diameter pipe.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Prices:
 - 1. Payment for water lines installed by open-cut, augered with or without casing, aerial crossing, and pipe offset section on linear foot basis for each size of pipe installed. Separate pay items are used for each type of installation (open cut and auger) measured along the axis of the pipe and includes all restrained joint fittings and appurtenances.
 - 2. When directed by Owner to install extra fittings, as required to avoid unforeseen obstacles, payment will be based on the following:
 - a. Extra fittings requested by the Owner and delivered to jobsite will be paid by the Owner.
 - b. Payment will include and be full compensation for items necessary for installation and operation of water line.

1.3 REFERENCES

- A. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile - Iron Pressure Pipe and Fittings.
- B. ANSI/NSF Standard 61 - Drinking Water System -Health Components.
- C. ASTM A 36 - Standard Specification for Carbon Structural Steel
- D. ASTM A 536 - Standard Specification for Ductile Iron Castings
- E. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- F. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.
- G. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

- H. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.
- I. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.
- J. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.
- K. ASTM E 709 - Standard Guide for Magnetic Particle Examination
- L. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
- M. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
- N. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.

1.4 SUBMITTALS

- A. Conform to requirements of OWNER specifications.
- B. Conform to submittal requirements of applicable Section for type of pipe used.
- C. Submit, a minimum of 15 calendar days before beginning pipe laying operations, layout drawing identifying proposed sections for disinfecting, hydrostatic testing and site restoration for entire project for review and approval. Layout drawing to identify sequence of sections for:
 - 1. Disinfection; not to exceed 2,000 linear feet per section.
 - 2. Hydrostatic testing and transfer of services; to immediately follow sequence of disinfected section.
 - 3. Site restoration; not to exceed limits specified; Sequence in order of disturbance.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Conform to applicable installation specifications for types of pipe used.
- B. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished. Provide watertight pipe and pipe joints.
- C. Lay pipe to lines and grades shown on Drawings. Use adequate surveying methods and equipment; employ personnel competent in use of equipment. Horizontal and vertical deviations from alignment as indicated on Drawings shall not exceed 0.10 feet. Measure and record “as-built” horizontal alignment and vertical grade at maximum of every 50 feet on record drawings.

- D. For pipe diameters 36 inches and greater, clearly mark each section of pipe and fitting with a unique designation on the inside of pipe. Minimum letter height shall be 4 inches.
- E. Laying Large-Diameter Water Main:
 - 1. Lay not more than 200 feet of pipe in trench ahead of backfilling operations.
 - 2. Dig trench proper width as indicated. When operations cause trench width below top of pipe to become 4 feet wider than specified, install higher class pipe or improved bedding, as determined by Engineer. No additional payment will be made for higher class of pipe or improved bedding.
 - 3. Prevent damage to coating when placing backfill. Backfill material shall be free of large rocks or stones, or other material which could damage coatings.
 - 4. Before assembling couplings, lightly coat pipe ends and outside of gaskets with cup grease or liquid vegetable soap to facilitate installation. Groove pipe to manufacturer's specifications.
- F. Confirm that nine feet minimum separation from gravity sanitary sewers and manholes from potable waterline.
- G. Where above clearances cannot be attained, and special design has not been provided on Drawings, obtain direction from the City before proceeding with construction.
- H. Inform Owner if unmetered sprinkler or fire line connections exist which are not shown on Drawings. Make transfer only after approval by the City.
- I. City will handle, at no cost to Contractor, operations involving opening and closing valves for wet connections and for chlorination. Contractor is responsible for handling necessary installations and removal of chlorination and testing taps and risers.
- J. If asbestos-cement (A.C.) pipe is encountered, follow safety practices outlined in American Water Works Association's publication, "Work Practices for A/C Pipe". Strictly adhere to "recommended practices" contained in this publication and make them "mandatory practices" for this Project.
- K. For pipe diameters 36 inches and greater, clearly mark each section of pipe and fitting with unique designation on inside of pipe along with pressure class. Locate unique identifying mark minimum of five feet away from either end of each section of pipe. Provide one unique identifying mark in middle of each fitting. Place markings at consistent locations. Use permanent black paint and minimum letter height of 4 inches to mark designations.
- L. Contractor is responsible for assuring chosen manufacturer fulfills requirements for extra fittings and, therefore, is responsible for costs due to downtime if requirements are not met.

3.2 HANDLING, CLEANING AND INSPECTION

A. Handling:

1. Place pipe along project site where storm water or other water will not enter or pass through pipe.
2. Load, transport, unload, and otherwise handle pipe and fittings to prevent damage of any kind. Handle and transport pipe with equipment designed, constructed and arranged to prevent damage to pipe, lining and coating. Do not permit bare chains, hooks, metal bars, or narrow skids or cradles to come in contact with coatings. Where required, provide pipe fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.
3. Hoist pipe from trench side into trench by means of sling of smooth steel cable, canvas, leather, nylon or similar material.
4. For large diameter water lines, handle pipe only by means of sling of canvas, leather, nylon, or similar material. Sling shall be minimum 36 inches in width. Do not tear or wrinkle tape layers.
5. Use precautions to prevent injury to pipe, protective linings and coatings.
 - a. Package stacked pipe on timbers. Place protective pads under banding straps at time of packaging.
 - b. Pad fork trucks with carpet or other suitable material. Use nylon straps around pipe for lift when relocating pipe with crane or backhoe.
 - c. Do not lift pipe using hooks at each end of pipe.
 - d. Do not place debris, tools, clothing, or other materials on pipe.
6. Repair damage to pipe or protective lining and coating before final acceptance.
7. Reject pipe with visible cracks (not meeting exceptions) and remove from project site.

B. Cleaning: Thoroughly clean and dry interior of pipe and fittings of foreign matter before installation, and keep interior clean until Work has been accepted. Keep joint contact surfaces clean until jointing is completed. Do not place debris, tools, clothing or other materials in pipe. After pipe laying and joining operations are completed, clean inside of pipe and remove debris.

C. Inspection: Before installation, inspect each pipe and fitting for defects. Reject defective, damaged or unsound pipe and fittings and remove them from site.

3.3 EARTHWORK

- A.** Conform to applicable provisions of Section 33 05 28 – Trenching and Backfill for Utilities.
- B.** Bedding: Use bedding materials in conformance with Section 33 05 28 – Trenching and Backfill for Utilities

- C. Backfill: Use bank run sand or earth or native soil as specified in Section 33 05 28 – Trenching and Backfill for Utilities. Backfill excavated areas in same day excavated. When not possible, cover excavated areas using steel plates on paved areas and other protective measures elsewhere.
- D. Place material in uniform layers of prescribed maximum 8-inch loose lifts and wet or dry material to approximately optimum moisture content. Compact to prescribed density. Water tamping is not allowed.
- E. Pipe Embedment: Including 6-inch pipe bedding and backfill to 12 inches above top of pipe.

3.4 PIPE CUTTING

- A. Cut pipe 12 inches and smaller with standard wheel pipe cutters. Cut pipe larger than 12 inches in manner approved by the City. Make cuts smooth and at right angles to axis of pipe. Bevel plain end with heavy file or grinder to remove sharp edges.

3.5 PIPING INSTALLATION

- A. General Requirements: *(Notify City immediately upon encountering wet conditions!)*
 - 1. Lay pipe in subgrade free of water.
 - 2. Make adjustments of pipe to line and grade by scraping away subgrade or filling in with granular material.
 - 3. Properly form bedding to fully support bell without wedging or blocking up bell.
 - 4. Open Cut Construction: Keep pipe trenches free of water which might impair pipe laying operations. Grade pipe to provide uniform support along bottom of pipe. Excavate for bell holes after bottom has been graded and in advance of placing pipe. Lay not more than nominal city block length of not more than 300 feet of pipe in trench ahead of backfilling operations. Cover or backfill laid pipe if pipe laying operations are interrupted and during non-working hours. Place backfill carefully and simultaneously on each side of pipe to avoid lateral displacement of pipe and damage to joints. If adjustment of pipe is required after it has been laid, remove and re-lay as new pipe.
- B. Install pipe continuously and uninterrupted along each street on which work is to be performed. Obtain approval of the City prior to skipping any portion of Work.
- C. Protection of Pipeline: Securely place stoppers or bulkheads in openings and in end of line when construction is stopped temporarily and at end of each day's work.
- D. Perform Critical Location as shown on Drawings. Refer to Section 33 05 28 – Trenching and Backfill for Utilities.
- E. Laying Large Diameter, 24-inch or greater Water Line

1. Lay not more than 200 feet of pipe (unless approved by the City) in trench ahead of backfilling operations.
 2. Dig trench proper width as shown. When trench width below top of pipe becomes 4 feet wider than specified, install higher class of pipe or improved bedding, as determined by the City. No additional payment will be made for higher class of pipe or improved bedding.
 3. Use adequate surveying methods and equipment; employ personnel competent in use of this equipment. Horizontal and vertical deviations from alignment as indicated on Drawings shall not exceed 0.10 feet. Measure and record "as-built" horizontal alignment and vertical grade at maximum of every 100 feet on record drawings.
 4. Prevent damage to coating when placing backfill. Use backfill material free of large rocks or stones (Maximum of 3-inch), or other material which could damage coatings.
 5. Before assembling couplings, lightly coat pipe ends and outside of gaskets with cup grease or liquid vegetable soap to facilitate installation.
 6. Prior to proceeding with critical tie-ins submit sequence of work based on findings from "critical location" effort.
- F. Perform following additional procedures when working on plant sites.
1. Seventy-two hours prior to each plant shut down or connection, schedule coordination meeting with City personnel. At this meeting, present proposed sequencing of Work and verification of readiness to complete Work as required and within time permitted. Do not proceed with Work until the City agrees key personnel, equipment and materials are on hand to complete Work.
 2. Prior to fully excavating around existing piping, excavate as minimal as possible to confirm type and condition of existing joints. Verify size, type, and condition of pipe prior to ordering materials or fully mobilizing for Work.
 3. Do not proceed with connections to existing piping and identified critical stages of work unless approved by the City and the City's Utility Maintenance Division operator is present to observe.
 4. Coordinate with City's Utility Department to obtain reduction in operating pressures prior to performing connections to existing piping.
 5. Make connections to existing piping only when two valves are closed off between connection and source of water pressure. Do not make connection relying solely on one valve, unless otherwise approved by the City.
 6. Perform critical stages of Work identified on Drawings at night or during low water demand months as specified in Division 1 Specifications.
 7. Excavation equipment used on plant sites to have smooth bucket; no teeth or side cutters.

8. Submit Lone Star Notification transmittal number to the City prior to beginning excavation.
 9. Before each "dig" with mechanical excavator, probe ground to determine potential obstructions. Repeat procedure until existing pipe is located or excavation reaches desired elevation. Perform excavations within one foot to existing piping by hand methods.
 10. Provide adequate notice to pipe manufacturer's representative when connecting or modifying existing prestressed or pretension concrete cylinder pipe.
 11. Provide field surveyed (horizontal and vertical elevations) "as-builts" of new construction and existing underground utilities encountered. Submit in accordance with Division 1 Specifications.
- G. For tie-ins to existing water lines, provide necessary material on hand to facilitate connection prior to shutting down existing water lines. Provide the City a minimum of one week notice prior to shutting down existing water lines. All valves shall be operated by City staff only.

3.6 JOINTS AND JOINTING

- A. Rubber Gasketed Bell-and-Spigot Joints for Concrete Cylinder Pipe, Bar Wrapped Pipe PVC, Steel, and DIP:
1. Lubricate gaskets with nontoxic water-soluble lubricant before pipe units are joined.
 2. Fit pipe units together in manner to avoid twisting or otherwise displacing or damaging rubber gasket.
 3. After pipe sections are joined, check gaskets to ensure that no displacement of gasket has occurred. If displacement has occurred, remove pipe section and remake joint as for new pipe. Remove old gasket, inspect for damage and replace if necessary before remaking joint.
 4. Where preventing movement is necessary due to thrust, use restrained joints as shown on Drawings.
 - a. Include buoyancy conditions for soil unit weight when computing thrust restraint calculations.
 - b. Do not include passive resistance of soil in thrust restraint calculations.
 5. Except for PVC pipe, provide means to prevent full engagement of spigot into bell as shown on Drawings. Means may consist of wedges or other types of stops as approved by Owner.
- B. Flanged Joints where required on Concrete Cylinder Pipe, Bar Wrapped Pipe, Ductile Iron Pipe, or Steel Pipe:

1. AWWA C 207. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle vertical, horizontal or north-south center line. Do not exceed 3/64 inch per foot inclination of flange face from true alignment.
2. Use full-face gaskets for flanged joints. Provide 1/8-inch-thick cloth inserted rubber gasket material. Cut gaskets at factory to proper dimensions.
3. Black nuts and bolts to match flange material. Use cadmium-plated steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Maintain at all times approximately same distance between two flanges at points around flanges. Tighten bolts alternately (180° apart) until all are evenly tight. Draw bolts tight to ensure proper seating of gaskets.
4. Full length bolt isolating sleeves and washers shall be used with flanged connections.
5. Furnish kits in accordance with Owner's "Approved Products List."

C. Restrained Joints

1. Restrain pipe joints with Mega lugs or approved equal and concrete thrust blocks. Onsite mixing of concrete shall not be allowed. (Batch mix only).
2. Thrust restraint lengths shown on Drawings are minimum anticipated lengths. These lengths are based on deflections indicated and on use of prestressed concrete cylinder pipe for large diameter lines and ductile iron pipe for small diameter lines. Adjustments in deflections or use of other pipe material may result in reduction or increase of thrust lengths. Perform calculations by pipe manufacturer to verify proposed thrust restraint lengths. Submit calculations for all pipe materials sealed by a Registered Professional Engineer in State of Texas for review by the City. Make adjustments in thrust restraint lengths at no additional cost to the City.
3. Passive resistance of soil will not be permitted in calculation of thrust restraint.
4. Installation.
 - a. Install restrained joints mechanism in accordance with manufacturer's recommendations.
 - b. Examine and clean mechanism; remove dirt, debris and other foreign material.
 - c. Apply gasket and joint NSF 61 FDA food grade approved lubricant.
 - d. Verify gasket is evenly seated.
 - e. Do not over stab pipe into mechanism.
5. Prevent any lateral movement of thrust restraints throughout pressure testing and operation. Place 3000 psi concrete for blocking at each bend, change in

direction of existing water lines, to brace pipe against undisturbed trench walls. Finish placement of concrete blocking, made from Type I cement, 4 days prior to hydrostatic testing of pipeline. Test may be made two days after completion of blocking if Type II cement is used.

- D. Make curves and bends by deflecting joints or other method as recommended by manufacturer and approved by the City.
 - 1. Deflection of pipe joints shall not exceed maximum deflection recommended by pipe manufacturer.
 - 2. If deflection is equal to or exceeds 5 percent from that specified, remove entire portion of deflected pipe section and install new pipe.
 - 3. Replace, repair, or reapply coatings and linings as required.
 - 4. Assessment of deflection may be measured by the City at location along pipe. Arithmetical averages of deflection or similar average measurement methods will not be deemed as meeting intent of standard.
 - 5. When rubber gasketed pipe is laid on curve, join pipe in straight alignment and then deflect to curved alignment.

3.7 SECURING, SUPPORTING AND ANCHORING

- A. Support piping as shown on Drawings and as specified in this Section, to maintain line and grade and prevent transfer of stress to adjacent structures.
- B. Where shown on Drawings, anchor pipe fittings and bends installed on water line by welding consecutive joints of pipe together to distance each side of fitting. Restrained length, as shown on Drawings, assumes that installation of pipe and subsequent hydrostatic testing begins upstream and proceed downstream, with respect to normal flow of water in pipe. If installation and testing differs from this assumption, submit for approval revised method of restraining pipe joints upstream and downstream of device used to test against (block valve, blind flange or dished head plug).
- C. Use adequate temporary blocking of fittings when making connections to distribution system and during hydrostatic tests. Use sufficient anchorage and blocking to resist stresses and forces encountered while tapping existing water line.

3.8 POLYETHYLENE WRAP

- A. Double wrap ductile iron pipe and appurtenances (except fire hydrants and fusion bond or polyurethane coated fittings) with 8-mil polyethylene film.
- B. Do not use polyethylene wrap if pipe is cathodically protected.

3.9 CLEANUP AND RESTORATION

- A. Cleanup and restore site as directed by the City.

3.10 CLEANING PIPING SYSTEMS

- A. Remove construction debris or foreign material and thoroughly broom clean and flush piping systems. Provide temporary connections, equipment and labor for cleaning. Owner must inspect water line for cleanliness prior to filling.

3.11 DISINFECTION OF WATER LINES

- A. Conform to TCEQ requirements for Disinfection of Water Utility Distribution.

3.12 FIELD HYDROSTATIC TESTS

- A. Conform to requirements of Division 1 Specifications.

END OF SECTION 33 11 13

SECTION 33 31 00 – SANITARY UTILITY SEWERAGE PIPING

PART 1 – GENERAL

SECTION INCLUDES

- A. Buried Pipe and Fittings
- B. Cleanouts
- C. Sewage Ejector
- D. Field Quality Control

1.01 RELATED SECTIONS

- A. Section 01 33 00 - Submittal Procedures
- B. Section 01 33 23 - Shop Drawings, Product Data, and Samples
- C. Section 01 45 00 – Quality Control
- D. Section 01 77 00 – Closeout Procedures
- E. Section 01 78 23 – Operation and Maintenance Data
- F. Section 01 78 39 – Project Record Documents
- G. Section 22 13 01 – Sanitary Sewerage
- H. Section 32 11 00 – Water Distribution Systems
- I. Section 31 00 00 – Earthwork
- J. Section 33 05 16 – Utility Structures
- K. Section 33 05 28 – Trenching and Backfilling for Utilities

1.02 MEASUREMENT AND PAYMENT

- A. General: Measurement and payment for the site sanitary sewerage system will be either by the lump-sum method or by the unit-price method as determined by the listing of the bid item for the site sanitary sewerage system indicated in the Bid Schedule of the Bid Form.
- B. Lump Sum: If the Bid Schedule indicates a lump sum for the site sanitary sewerage system, the lump-sum method of measurement and payment will be in accordance with Section 01 20 00 - Price and Payment Procedures, under Article entitled “Lump-Sum Measurement”.
- C. Unit Price: If the Bid Schedule indicates a unit price for the site sanitary sewerage system, the unit-price method of measurement and payment will be as follows:

1. Measurement:

- a. Site sanitary sewerage system will be measured for payment by the linear foot of pipe, installed in place and tested, for each type and size, along the centerline of the pipe, with deductions made for manholes or other structures, measured from the inside face of each structure.
- b. Utility structures will be measured separately for payment as specified in Section 33 05 16 - Utility Structures.
- c. Pipe fittings, joints, pipe bedding, cleanouts, collar taps, and cutting of pipe will not be measured separately for payment, and all costs in connection therewith will be considered as included in the linear foot measurement for pipe.
- d. Support of trench excavation, maintenance, support of existing utility facilities, excavation and backfill, concrete, and incidental work pertaining to the installation of sewer pipe will not be measured separately for payment, but will be considered as included in the linear foot measurement for sewer pipe.

2. Payment: Site sanitary sewerage system will be paid for at the indicated Contract unit prices for the computed quantities as determined by the measurement method specified in Article 1.03.C.1.

1.03 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI A21.11 Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings

B. American Society for Testing and Materials (ASTM):

2. ASTM A74 Specification for Cast Iron Soil Pipe and Fittings

3. ASTM C12 Practice for Installing Vitrified Clay Pipe Lines

4. ASTM C14 Specification for Concrete Sewer, Storm Drain, and Culvert Pipe

5. ASTM C76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

6. ASTM C425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings

7. ASTM C443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets

8. ASTM C564 Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

9. ASTM C700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated

10. ASTM D1785 Specification for Poly (Vinyl Chloride) (PVC)

Plastic Pipe, Schedules 40, 80, and 120.

11. ASTM C2321 Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe

12. ASTM D2466 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings, Schedule 40

13. ASTM D2564 Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) plastic Pipe and Fittings

14. ASTM D2565 Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, Vent Pipe, and Fittings

15. ASTM D2729 Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

16. ASTM D2855 Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

17. ASTM D3139 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

18. ASTM F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. American Water Works Association (AWWA):

1. ANSI/ Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch AWWA C900 through 12 inches for Water Distribution

D. Sanitary Utility District Standards: Note that all work shall be performed and completed in accordance with the jurisdictional sanitary utility district's standard drawings and specifications. The Contractor shall be responsible for obtaining all such standards and for compliance with such standards as applicable.

1.04 SUBMITTALS

A. Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submit Shop Drawings showing piping layouts, sizes, types, cleanouts, and the sewage structure ejector station.

C. Submit the respective manufacturers' product data for manufactured materials and equipment.

D. Submit equipment manufacturer's printed operating and maintenance instructions in accordance with Section 01 78 23 - Operation and Maintenance Data, consisting of a detailed parts list, a recommended spare parts list, and complete operation and maintenance procedures.

E. Submit certified test reports of equipment, as applicable.

1.05 SUBMITTALS FOR CLOSEOUT

- A. Refer to Section 01 77 00 - Closeout Procedures, and Section 01 78 39 - Project Record Documents, for submittal requirements and procedures.
- B. Record actual location of piping mains, valves, connections, thrust restraints, and invert elevations.

1.06 SITE CONDITIONS

- A. Excavations shall be dry immediately before and after products are installed. Provide surfaces and structures to, and on which sewerage products will be installed.
- B. Coordinate the installation of the sanitary sewerage system with the jurisdictional sanitary district or utility owner.

PART 2 - PRODUCTS

2.01 BURIED PIPE AND FITTINGS

- A. Requirements: Provide the types, sizes, and configurations of pipe, fittings, and miscellaneous materials and installation accessories as indicated and required. Pipe ends shall be bell and spigot, except plain end pipe shall be joined with mechanical clamp and gasket joint.
- B. PVC Pipe and Fittings, 3 Inches and Smaller:
 - 1. Pipe: Polyvinyl chloride (PVC), conforming with ASTM D1785, Schedule 40 or 80, as indicated, Type I, Grade 1, bell and spigot style solvent sealed jointed.
 - 2. Fittings: ASTM D2466, Socket Weld, same material and schedule as pipe.
 - 3. Joints: Socket welded with PVC solvent cement conforming with ASTM D2564 and ASTM D2855.
- C. PVC Pipe and Fittings, 4 Inches and Larger:
 - 1. Pipe: AWWA C900, Class 200, Poly (Vinyl Chloride) (PVC) Water Pipe with Bell and Spigot Ends and Flexible Ring Joints.
 - 2. Fittings: ASTM D2466, Type 1, Grade 1, Poly (Vinyl Chloride) (PVC) Fittings, Class 200.
 - 3. Joints: ASTM D3139 gasketed bell joints with ASTM F477 gaskets.
- D. Cast Iron Soil Pipe:
 - 1. Pipe: ASTM A74.
 - 2. Joint Devices: ASTM C564 or ANSI A21.11, rubber gasket joint devices, as applicable.
- E. Clay Pipe:
 - 1. Pipe: ASTM C700, unperforated.
 - 2. Joint Device: ASTM C425, compression joint.

F. Concrete Pipe:

1. ASTM C14, Class 3, unreinforced.
2. Joint Device: ASTM C443, rubber compression gasket joint.

G. Reinforced Concrete Pipe:

1. Pipe: ASTM C76, Class III, with steel reinforcement.
2. Joint Device: ASTM C443, rubber compression gasket joint

H. Pipe Accessories:

1. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, with neoprene ribbed gasket for positive seal.
2. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers traps, and other configurations as indicated or required.

I. Pipe Bedding Material: Clean sand as specified in Section 33 05 28 - Trenching and Backfilling for Utilities.

2.02 CLEANOUTS

- A. At grade cleanouts shall have an adjustable sleeve-type housing, a threaded brass plug with countersunk slot, and cast-iron frame and cover.

2.03 SEWAGE EJECTOR

- A. Provide in accordance with applicable requirements of Section 22 14 29 - Sump Pumps.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut excavation base is ready to receive work and that excavations, dimensions, and elevations are as indicated.

3.02 PREPARATION

- A. Excavations shall be free of water and extraneous material immediately before sanitary sewerage products are installed or placed. Bottoms of trenches shall have a 6-inch sand bed and shall be formed to support the bottom quadrant of the pipe and fittings. Should rock be encountered or should bedding material be unsuitable to support the products at design elevation, continue excavation to an elevation 8 inches below the design elevation and backfill with clean sand.
- B. Hand trim excavations to required elevation.
- C. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling and compacting operations.

- D. Interior of pipe, pipe fittings, valves, drains, and cleanouts shall be cleaned of foreign substances before installation.

3.03 INSTALLATION REQUIREMENTS

- A. Excavate pipe trench in accordance with Section 33 05 28 - Trenching and Backfilling for Utilities. Hand-trim bottom of trench to approximately 6 inches below invert of pipe.
- B. Top of pipe to finished grade shall be 30 inches unless otherwise indicated or approved by the Engineer.
- C. Place sand bedding material meeting the requirements of Section 33 05 28 - Trenching and Backfilling for Utilities, at trench bottom, level in one continuous layer not exceeding 8 inches in compacted depth. Compact bedding to 95 percent relative density.
- D. Backfill around sides and to 6 inches above pipe with cover fill tamped in place and compacted to 95 percent relative density.
- E. Test pipe distribution system and place tracer wire on top of pipe as specified herein prior to covering pipe. Backfill trench in accordance with Section 33 05 28 - Trenching and Backfilling for Utilities.
- F. Maintain optimum moisture content of bedding material to attain required compaction density.
- G. Install products where indicated. Remove and reinstall products that are disturbed after installation. Ends of products to which future connections will be made shall be either valved, or properly plugged, capped, and anchored.
- H. Connections to existing facilities shall be made with fittings and short bends to suit the actual conditions. Connect products in accordance with the product manufacturer's installation instructions.
- I. Pipe and fittings shall be set to line and grade before joints are made up. Angular deflections of joints shall not exceed the recommendations of the pipe and fitting manufacturer. Should the alignment require deflection of joints to be in excess of those recommended, use special bends to achieve the indicated deflection. Pipe ends and joints shall be prepared in accordance with the manufacturer's recommendations. As a minimum, pipe ends shall be sanded and cleaned, fittings shall be cleaned, and solvent shall be applied to both pipe and fittings.
- J. Install pipe, fittings, and accessories in accordance with ASTM C12, ASTM D2321, and the manufacturer's instructions. Seal joints water tight.
- K. Lay pipe to slope gradients as indicated.
- L. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches, compacted to 95 percent relative density.

3.04 INSTALLING PIPE

- A. Protect pipe and fittings during handling to prevent damage.
- B. Place, shape, and compact bedding material to receive barrel of pipe.
- C. Start laying pipe at the lowest point; lay true to line and grade indicated.
- D. Install pipe to bear on bedding material along its entire length.

- E. Do not place the pipe on blocking material of any type.
- F. Do not use wedges while installing the pipe.
- G. Install pipe so that bells and grooves are on the upstream end.
- H. Align each section of pipe with adjoining section leaving a uniform annular space between the bell and spigot to prevent sudden offsets in flow line.
- I. As each section of pipe is laid, place sufficient bedding and backfill to hold it firmly in place.
- J. Apply lubricant to rubber gasket (O-rings) immediately before joining pipe sections.
- K. Keep interior of sewer clean as work progresses. Where small pipe sizes make cleaning difficult, keep a suitable swab and pulling line in the pipe, and pull through each joint immediately after jointing is completed.
- L. Keep trenches and excavations dry and free of water during construction and until backfilling and compaction are completed.
- M. When work is not in progress, securely plug ends of pipe and fittings to prevent extraneous matter from entering pipes and fittings.
- N. Cut pipe ends, which project into a sewer structure, flush with the inside face of the structure and cover exposed pipe reinforcement with grout.
- O. Where length of stub is not indicated, install a 4-foot length, and seal the free end with brick masonry bulkhead or an approved stopper.
- P. Obtain the Engineer's approval before covering pipe.
- Q. Where indicated, place additional bedding material around and over the pipe in lifts not exceeding 6 inches before compaction. Compact each lift before placement of the next lift.
- R. Accomplish compaction by methods that will avoid damage to pipe and will not disturb its alignment and grade. The use of vibratory rollers is prohibited until compacted cover over pipe has reached 3 feet or half the pipe diameter; whichever is greater.
- S. Connect sanitary sewerage system to existing public sanitary sewers in accordance with requirements of the jurisdictional authority.

3.05 PIPE CLEANOUTS

- A. Installation: Cleanouts shall be the same size as the pipe, with 4-inch diameter as a minimum. Cleanouts for drainage pipe shall consist of a long sweep 1/4 bend, or one or two 1/8 bends extended to the location indicated. Wall or accessible piping cleanouts shall be T-pattern, 90 degree branch drainage fittings having screw plugs. Cleanouts shall be provided at the base of each riser and shall consist of a wye pattern fitting with a screw plug.
- B. Form and place cast-in-place concrete pad with provision for sanitary sewer pipe ends.
- C. Establish elevations and invert for inlets and outlets.

D. Mount cleanout surface hub level in grout to elevation indicated.

3.06 FIELD QUALITY CONTROL

A. Requirements:

1. Refer to Section 01 45 00 - Quality Control, for field inspection and testing requirements.
2. Where drainage piping is located below invert slabs, conduct a ball, shuttlecock, or mandrel test to ensure that the line is free of obstructions subsequent to the placing of pervious backfill material over the line and prior to the placement of the concrete invert slab.
3. Upon completion of the test and determination that the line is free of obstructions, plug, cap, or otherwise close the open end or ends of the installed piping to prevent the entrance of debris into the lines.
4. Immediately prior to final inspection of the work, remove debris from manholes, drain inlets, and floor scupper drains. In the presence of the jurisdictional sanitary utility owner's representative prove by one of the methods specified above that the piping is free of obstructions.
5. The Contractor shall be responsible for making all necessary arrangements with the jurisdictional sanitary utility owner for performing and witnessing the required tests.
6. Request inspection of exposed piping prior to placing backfill.
7. Compaction testing of related earthwork shall be performed in accordance with applicable requirements of Section 31 00 00 - Earthwork.
8. If tests indicate work does not meet requirements, remove such work, replace, and retest at no additional cost to the District.

B. Sanitary Pipeline Tests:

1. Perform air tests on all installed sanitary sewer pipes upon completion of backfill.
2. Hydrostatically test all installed sanitary sewer force mains.
3. Test all manholes for infiltration or exfiltration.
4. Test pipe sections by the exfiltration test.
5. Test sewer 24 inches or less in diameter with low pressure.
6. Sewers with a diameter greater than 24 inches may be tested by visual inspection.

C. Exfiltration Test:

1. Tightly plug end of pipe at downstream manhole.
2. Fill sewer, at either upstream manhole or standpipe, with water.
3. Allow water to stand for not less than eight hours, and until pipe has become saturated. Refill

manhole or pipe to measuring mark and begin test.

4. Exfiltration will be determined as follows:

a. If standpipe has been filled, maintain a head of water not less than 2 feet nor more than 15 feet above highest point in the line being tested.

1) Exfiltration: that volume of water added to standpipe during a 20-hour period.

b. If upstream manhole has been filled, measure original water elevation and, after 20 hours, final water elevation. Convert difference in elevation to gallons. Head of water shall be not less than 2 feet above highest point in the line being tested or not less than 2 feet above existing groundwater table, whichever is greater.

1) Exfiltration: that volume of water calculated from the difference in elevations during a 20-hour period.

5. Allowable leakage:

a. Not more than 200 gallons per 24 hours per diameter inch per mile of sewer.

b. If leakage exceeds permissible loss, sewer section will not be accepted.

c. Do not conduct another exfiltration test until conditions of groundwater surrounding pipe return to a condition similar to those existing at beginning of test period.

D. Infiltration Test:

1. Tightly plug end of pipe at upstream manhole.

2. Install a 90-degree notch weir in downstream manhole.

3. Allow water to accumulate behind weir until overflow is constant.

4. Allowable leakage:

a. Not more than 200 gallons per 24 hours per diameter inch per mile of sewer.

b. If measured infiltration is more than the allowable rate, sewer section will not be accepted.

E. Low-Pressure Air Test:

1. Clean and set sections of pipe to be tested before starting air test.

2. Plug pipe outlets with pneumatic plugs capable of resisting internal testing pressures without requiring external bracing.

3. Immediately following pipe cleaning and wetting, slowly supply air to plugged pipe until internal air pressure reaches 4 psi. Allow at least two minutes for temperature to stabilize before proceeding, except slowly add air to maintain a 3.5 psig to 4 psig pressure. While temperature is stabilizing, spray plugs, pipes, and hoses with soap solution and eliminate air leaks.

4. After temperature has stabilized, measure time required for pressure to drop from 3.5psig to 2.5 psig. If measured time exceeds allowable time, pipe will not be accepted.

5. Time, in seconds, for pressure to drop from 3.5 to 2.5 psig shall be not less than the following: time for intermediate lengths shall be interpolated:

Pipe (Ft)	Length of Pipe Diameter in Inches						
	8	10	12	15	18	21	24
25	18	28	40	62	89	121	158
50	35	55	79	126	178	243	317
75	53	83	119	186	267	364	475
100	70	110	158	248	356	485	634
125	83	38	198	309	444	595	680
150	100	165	238	375	510	595	680
175	123	193	277	425	510	595	680
200	141	120	317	425	510	595	680
225	158	248	340	425	510	595	680
250	176	275	340	425	510	595	680

F. Visual Test Method: Slowly pull a television camera through sewer and inspect for visual leaks and cracks in pipe. Repair leaks, then re-inspect pipe.

G. Joint Pressure Testing:

1. Insert sealing packer with joint testing capability, into sewer line.
2. Place sealing packer around joint and pressure test joint. If a drop in air pressure occurs, reseal the joint.
3. Repeat procedure for each joint.

H. Criteria for Acceptance: The section of sewer being tested will not be accepted if test results exceed allowable leakage or take less time than minimum holding time. If pipe proves to be unacceptable, immediately repair defective materials and installation. The Contractor will not be permitted to change to another test if original test method reveals system has failed.

I. Obstruction Tests:

1. Perform field tests to verify that installed sanitary systems are free from obstructions.
2. Remove obstructions by excavating at the apparent obstruction and repairing or replacing the defective pipe.

END OF SECTION 33 31 00

SECTION 33 41 00 – STORM SEWAGE SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This Section specifies the requirements for providing storm sewers and appurtenant structures.

1.2 QUALITY ASSURANCE

- A. Reference Standards Applicable to this Section

1. AASHTO: American Association of State Highway and Transportation Officials
 - a. M 36: Specification for Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains.
 - b. M 190: Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
 - c. M 252: Specification for Corrugated Polyethylene Drainage Tubing.
 - d. M 294: Specification for Corrugated Polyethylene Pipe 12 inch to 36-inch diameter.
2. ASTM: American Society for Testing and Materials
 - a. A 48: Specification for Gray Iron Castings.
 - b. A 74: Specification for Cast Iron Soil Pipe and Fittings.
 - c. C 40: Test Method for Organic Impurities in Fine Aggregate for Concrete.
 - d. C 76: Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
 - e. C 150: Specification for Portland Cement.
 - f. C 443: Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.
 - g. C 881: Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - h. D 618: Conditioning Plastics and Electrical Insulating Materials for Testing.
 - i. D 1248: Polyethylene Plastics Molding and Extrusion Material.
 - j. D 1693: Environmental Stress Cracking of Ethylene Plastics.
 - k. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - l. D 2239: Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.

- m. D 2412: Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- o. D 2447: Specifications for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
- p. D 2466: Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- q. D 2467: Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- r. D 2564: Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- s. D 2665: Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
- t. D 2729: Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- u. D 2855: Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- v. D 3035: Specifications for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
- w. D 3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- x. D 3261: Specification for Butt Heat Fusion of Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- y. D 3350: Specification for Polyethylene Plastics Pipe and Fittings Material.
- z. F 402: Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings.
- aa. F 405: Specification for Corrugated Polyethylene (PE) Tubing and Fittings.
- bb. F 412: Standard Terminology Relating to Plastic Piping Systems.
- cc. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- dd. F 656: Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Pipes and Fittings.
- ee. F 714: Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- ff. F 913: Standard Specification for Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- gg. F 667: Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings.

3. Federal Specification
 - a. SS-S-210A and Latest Amendments: Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.
4. Rosenberg
 - a. Standard Construction Specifications for Wastewater Collection Systems, Water Lines, Storm Drainage and Street Paving, September 1996 or latest revision.

1.3 SUBMITTALS

- A. In accordance with Section 013300 – Submittal Procedures of these Specifications, the following shall be submitted:
 1. Certificates
 - a. Manufacturer's certificates and load tickets stating that materials meet specified requirements.
 2. Shop Drawings
 - a. Shop Drawings and details of all storm sewers and drains, including relationship to other systems and true position and details of all interfaces, connections, inlets, clean-outs, manholes, alignment and grade, changes of direction, offsets, bedding and protection, materials, manufacturer's installation and connection instructions and recommendations, and all other pertinent data.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Products for use within right-of-way shall meet the applicable requirements.

2.2 PIPES AND FITTINGS

- A. Reinforced Concrete Pipe (RCP)
 1. ASTM C 76, bell-and-spigot, Class III, Wall B.
- B. Corrugated Galvanized Metal Pipe (CGMP)
 1. AASHTO M 36, coated and paved in accordance with AASHTO M 190, Type C coating for pipe and Type A coating for coupling bands.
- C. PVC Pipe in accordance with the following:
 1. ASTM D 1785.
 2. ASTM D 2241.

3. ASTM D 2466.

4. ASTM D 2467.

D. PE Pipe

1. ASTM D 2447.

2. ASTM D 3035.

3. ASTM D 3350 Type PE 3408.

4. ASTM F 714 Type PE 3408.

2.3 JOINTS

A. Gaskets for RCP in accordance with the following:

1. Federal Specification SS-S-210A.

2. ASTM C 443.

B. All joints in PVC plastic pipe shall be solvent cemented in accordance with the following:

1. ASTM D 2564.

2. ASTM D 2672.

3. ASTM D 2855.

4. ASTM F 402.

5. ASTM F 656.

C. All joints in PE plastic pipe shall be fusion butt-welded in accordance with ASTM3261.

2.4 DRAINAGE STRUCTURES

A. Manhole

Type as indicated on the Drawings and conforming to applicable Standards for Sugar Land or FBCDD Right-of-Way. Frame and Cover ASTM A 48 Class 35 B.

B. Inlet

Type as indicated on the Drawings and conforming to applicable Standards in Sugar Land or FBCDD Right-of-Way. Frame and Grate ASTM A 48 Class 35 B.

C. Reinforcing Steel

As specified in Section 032100 - Concrete Reinforcement of these Specifications.

D. Cast-in-Place Concrete (Class 3000)

As specified in Section 321373.19 - Cast-in-Place Concrete of these Specifications.

E. Mortar (Type M)

2.5 CEMENT-STABILIZED SAND BACKFILL

A. Aggregate

Use clean sand; deleterious materials in the sand shall not exceed the following limitations, by weight:

Material removed by denatation	5.0 percent
Clay lumps	0.5 percent
Other deleterious substances such as coal, shale, coated grains of soft flaky particles.	2.0 percent

Gradation Requirements:

Retained on 3/8-in. sieve	0 percent
Retained on 1/4-in. sieve	0 - 5 percent
Retained on 20-mesh sieve	15 - 50 percent
Retained on 100-mesh sieve	80 - 100 percent

Color test per ASTM C 40, color not darker than standard color.

B. Cement

ASTM C 150, Type I or II.

C. Water

Potable, from municipal supplies approved by the State or City Health Department.

D. Mixture

Use at least 1-1/2 sacks of cement per cubic yard of mixture. Use amount of water required to provide mix suitable for mechanical hand tamping and mix in approved mixer. Stamp load tickets at plant with time of loading. Material not in place within 1-1/2 hours after loading or that has obtained an initial set will be rejected and shall be removed from the Site and replaced with new acceptable mixtures at no additional cost to OWNER.

2.6 TIMBER POSTS

A. Southern Pine or Douglas Fir, pressure-treated in accordance with American Wood Preservers' Association (AWPA) Standards.

PART 3 - EXECUTION

3.1 GENERAL

- A. All storm sewer work performed within Houston right-of-way shall meet the applicable requirements.

3.2 EXCAVATION

- A. All excavation shall be in accordance with Section 017330 - Trench Safety Systems of these Specifications.
- B. Perform excavation for storm sewer and storm sewer drainage structures to line and grade required as shown on the Drawings and as specified herein.
- C. If the excavation exceeds the permissible dimensions, extend the encasement or install pipe of higher strength, as directed.
- D. Prevent surface or ground water from flowing into excavation. Install, operate, and maintain dewatering system to convey water away from excavation. Notify the Engineer in writing of delays to the Work caused by water intrusion.

3.3 PIPE ENCASEMENT

- A. Place cement-stabilized sand bedding before laying pipe. Bedding shall be compacted and shaped to fully support the pipe.
- B. After the pipe is laid, place cement-stabilized sand beside and above the pipe in 4 in. lifts to the limits shown on the construction drawings. Compact individual lifts with a hand-operated, motorized tamper; exercise care to avoid damaging the pipe.

3.4 LAYING PIPE

- A. Install and joint pipe in accordance with the pipe manufacturer's instructions and as specified herein.
- B. Provide a minimum of 6 in. clearance between storm sewer and sanitary sewer.
- C. Seal open end of pipe with plug when pipe laying operation is temporarily halted. Plug shall remain in place until operation restarts.

3.5 BACKFILL

- A. On completion of construction, backfill the excavation as specified in Section 312300 –Grading, Excavation and Fill of these Specifications and in accordance with details on the construction drawings. Backfill only when the written approval of the Engineer is obtained to do so.

3.6 CONSTRUCTION OF MANHOLES AND INLETS

- A. General
 - 1. Construct manholes and inlets as soon as practical after sewer lines into or through the manhole or inlet locations are completed.

2. Construct manholes and inlets at locations and of the type indicated. All manholes within 9 feet of existing water lines shall be watertight.

B. Manholes

1. Provide base of the shape and size required with a minimum thickness of 12 inches.
2. Place axis of manholes directly over the centerlines of the lines, unless otherwise indicated.
3. Shall be constructed of either precast or cast-in-place concrete.

C. Inlets

1. Shall be constructed of either precast or cast-in-place concrete.

3.7 CLEANUP

- A. Remove temporary structures, rubbish, waste materials, and excess excavated materials from the Site and dispose of legally.

END OF SECTION 33 41 00



FORT BEND COUNTY - PRECINCT 3 ANNEX



AUTOARCH Architects, LLC.

www.autoarch.net

(713) 952 - 3366

Civil Engineer

Dally Associates
9800 Richmond Avenue, Suite 460
Houston, TX 77042
(713) 337-8881

Structural Engineer

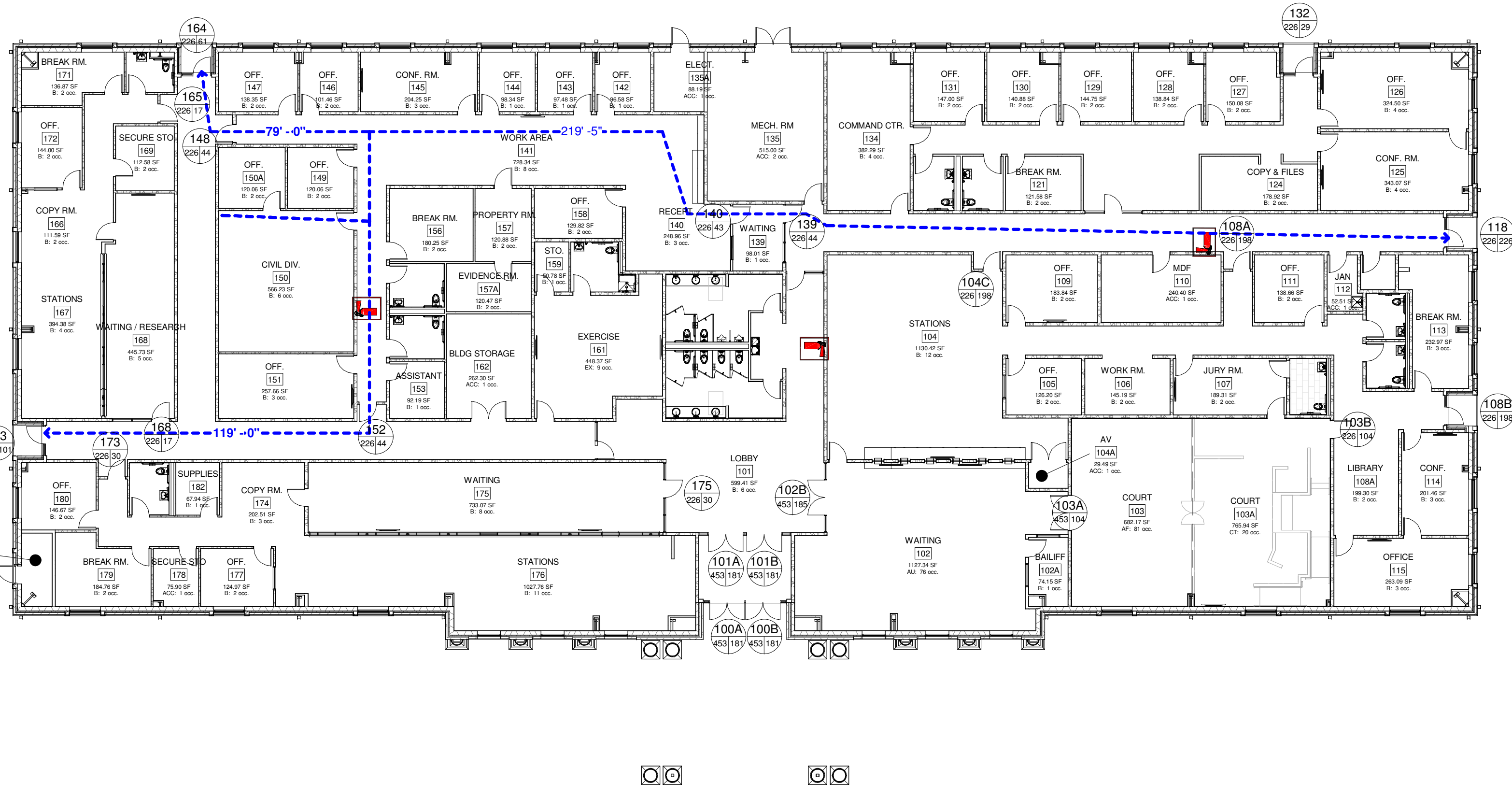
Dally Associates
9800 Richmond Avenue, Suite 460
Houston, TX 77042
(713) 337-8881

MEP Engineer

Infrastructure Associates
6117 Richmond Avenue, Suite 200
Houston, TX 77057
(713) 622-0120

Landscape Architect

Greenscape Associates
5030 Bryan Rd.
Rosenberg, TX 77469
(281) 341-9985



29 EGRESS PLAN

Scale: 1/16" = 1'-0"

ROOM TAG & OCCUPANCY CLASSIFICATIONS

ROOM - Room Name
101 - Room Number
159 SF - Room Area
10 - Occupant Count
Occupant Classification

Occupancy Classifications are based on Table 1004.1.2 in the 2015 International Building Code (IBC). In this project they include:

ACC: Accessory, 300 gs/fooc
AU: Assembly, Unconcentrated: 15 nst/fooc
AF: Assembly, Fixed Seats: re: Sec 1004.4
CT: Courtroom, 40 nst/fooc
B: Business Area, 100 gs/fooc

DOOR TAG & EGRESS CAPACITIES

101 - Door Number
Actual Egress Through Door
Egress Capacity of Door

Egress Capacities are based on Section 1005.1.1 of the 2015 International Building Code. Door Capacity is 0.15" per Occupant in a 100% Sprinklered Building.

Egress Path, Arrow indicates direction.
Egress Length

RATED PARTITIONS & FIRE WALLS

1 HR
2 HR
3 HR

FIRE EXTINGUISHERS

Fire Extinguisher in Semi-Recessed Cabinet (Protrudes ≤ 4" from wall).
Fire Extinguisher

These graphics indicate rated partitions unless noted as Fire Walls in this drawing.

28 EGRESS & CODE LEGEND

Scale: NTS

A.F.F.	ABOVE FINISHED FLOOR	LBS.	POUNDS
ALUM.	ALUMINUM	MAX.	MAXIMUM
BLDG.	BUILDING	MFR.	MANUFACTURER
CL.	CENTER LINE	MN.	MINIMUM
CMF.	COLD FORMED METAL FRAMING	MISC.	MISCELLANEOUS
CFM.	CUBIC FEET PER MINUTE	M.O.	MASONRY OPENING
CMU.	CONCRETE MASONRY UNITS	MTD.	MOUNTED
COL.	COLUMN	MTL.	METAL
CONC.	CONCRETE	N.I.C.	NOT IN CONTRACT
CONT.	CONTINUOUS	NO.	NUMBER
COIL.	CYLINDER	NTS.	NOT TO SCALE
DOCS.	DOCUMENTS/DRAWINGS	O.C.	ON CENTER
EA.	EACH	O.D.	OUTSIDE DIMENSION
E.I.F.S.	EXTERIOR INSULATION & FINISH SYSTEM	OPP.	OPPOSITE
ELEV.	ELEVATION	O.S.B.	ORIENTED STRAND BOARD
E.S.C.	EXTERIOR SPECIAL COATING	PLYWD.	PLYWOOD
F.D.	FLOOR DRAIN	P.S.F.	POUNDS PER SQUARE FOOT
F.O.C.	FACE OF CURB/CONCRETE	P.S.I.	POUNDS PER SQUARE INCH
F.Q.M.	FACE OF MASONRY	REQD.	REQUIRED
FIN.	FINISHED	R.O.	ROUGH OPENING
FLR.	FLOOR	SHATH.	SHEATHING
FT.	FEET	SIM.	SIMILAR
FR.S.	FIRE RETARDANT WOOD TREATMENT	SPECS.	SPECIFICATIONS
GA.	GUAGE	STL.	STEEL
GALV.	GALVANIZED	STRUCT.	STRUCTURAL
G.I.	GALVANIZED IRON OR STEEL	SG.	SQUARE
G.L.	GRADE LEVEL	T & G.	TONGUE & GROOVE
G.P.B.	GYPSPUM BOARD	T.D.	TOP OF DRAIN
G.P. BD.	HOLLOW METAL	T.O.	TOP OF
H.M.	HOLLOW METAL	T.O.C.	TOP OF CURB/CONCRETE
HR.	HOUR	TYP.	TYPICAL
HT.	HEIGHT	W.	WITH
H.V.A.C.	HEATING VENTILATING & AIR CONDITIONING	W.P.	WEATHERPROOF
I.D.	INSIDE DIMENSION	W.F.	WELED WIRE FABRIC
IN.	INCH	W.W.F.	WELED WIRE FABRIC

27 ABBREVIATIONS LEGEND

Scale: NTS

NORTH TRUE NORTH

NORTH ARROW

BUILDING SECTION
05/A5.10

WALL SECTION
02/A6.02

BUILDING ELEVATION
05/A8.03

INTERIOR ELEVATION
05/A8.03

SECTION DETAIL
06/A2.10

ENLARGED DETAIL

FIRE RATED NOT RATED

PARTITION TYPE

01 ELEVATION
SCALE: 1/8" = 1'-0"

21 GRAPHICS LEGEND

Scale: NTS

PLANS

Vinyl Composition Tile (VCT)

Luxury Vinyl Tile (LVT)

Carpet (CPT)

ELEVATIONS

Metal Wall Panels

Aluminum Composite Material (ACM) Panels

Plaster or Stucco

Brick

Glazing

SECTIONS & PLAN DETAILS

Earth

Concrete

Brick

Concrete Masonry Units (CMU)

Dimensional Wood

Finished Wood

Thermal Batt Insulation

Sound Attenuation Batts (SABs)

Rigid Insulation

Plywood

16 GENERAL PROJECT NOTES

Scale: NTS

This set of Contract Documents includes both Technical Specifications and Drawings. The installation / application information herein is not to be considered complete unless all of the sheets listed in the Index are present.

All Contractors and Bidders must read the Entirety of the Written Specifications and Drawings Contained in the Contract Documents.

The Drawings indicate the Overall Design Intent, as well as dimension and quantity of building materials, products, and components to be placed or installed.

Only the most current signed and sealed drawings and specifications shall be used for bidding, permitting, and construction purposes.

These Contract Documents are the Instrument of Services Rendered, and shall remain the property of the architect whether the project for which they are prepared is executed or not. Any use of these Contract Documents for purposes other than the execution of this project, without the architect's written consent, is prohibited. Any unauthorized use of these Contract Documents is at the sole risk of the user.

Architect is responsible only for those underground utilities and tie-in locations that appear accurately on the County's record drawings. Any deviation from these records shall be independently verified and located by the General Contractor.

All Contractors working on this project must abide by all applicable Federal, State, and Local Codes and Ordinances, as well as the requirements of the Development in which the project is located. Any conflicting requirements, or requests for interpretation of requirements, should be called to the architect's attention prior to the start of work.

Contractor shall Field Verify All conditions and dimensions, with special attention given to building location, grid-lines, and structural dimensions, prior to the start of work.

Contractor shall notify the architect of any discrepancies between Drawings, Specifications, and Site Conditions immediately upon their discovery.

12 PROJECT & CODE INFORMATION

Scale: NTS

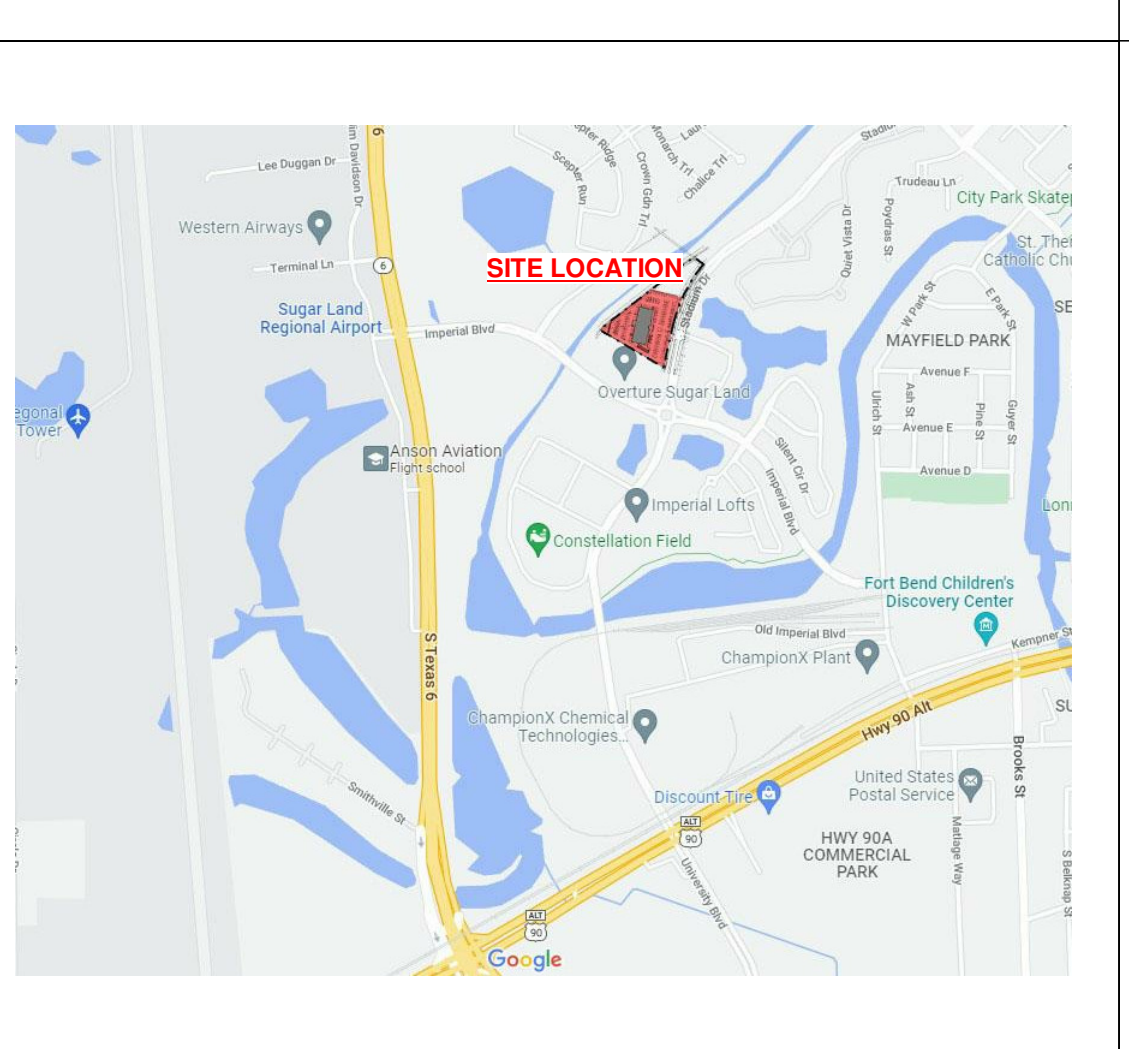
Deviations from the Drawings and Specifications are prohibited without express written approval of the Architect.

All Contractors shall coordinate their work with that of other contractors working on site, and shall comport themselves in a professional manner. Concerns shall be brought to the General Contractor. The General Contractor shall be responsible for the Subcontractors' work, in accordance with these Contract Documents.

All Work required to complete the project, including work not indicated in these documents but necessary for the project's completion, shall meet general professional standards, applicable codes and regulations, and manufacturer's recommendations.

All controls shall be mounted at 42" above finished floor, unless indicated otherwise.

06 PROJECT VICINITY



02 SHEET INDEX

Scale: NTS

MEP SITE	MEP1.00	SITE PLAN
MECHANICAL	M0.00	SYMBOLS, NOTES, & LEGENDS
	M1.01	SCHEDULES
	M2.01	ZONING PLAN
	M3.00	CONTROLS
	M4.01	DETAILS
	M4.02	DETAILS
ELECTRICAL	E0.00	NOTES AND LEGEND
	E0.10	ONE LINE DIAGRAM
	E0.11	PANEL SCHEDULES
	E0.12	PANEL SCHEDULES
	E2.01	FLOOR PLAN - POWER
	E2.02	FLOOR PLAN - EQUIPMENT
	E3.01	FLOOR PLAN - LIGHTING
	E4.01	FLOOR PLAN - FIRE ALARM
	E5.01	DETAILS
	E5.02	DETAILS
PLUMBING	P0.01	NOTES AND LEGEND
	P0.02	FIXTURE SCHEDULE
	P2.01	FLOOR PLAN - SANITARY
	P3.01	FLOOR PLAN - DOMESTIC
	P4.01	DETAILS
	P5.01	RISER DIAGRAM - SANITARY
	P5.02	RISER DIAGRAM - DOMESTIC
FIRE PROTECTION	FP1.01	FIRE PROTECTION PLAN AND NOTES
	FP1.02	FIRE PROTECTION PLAN

01 PROJECT LOCATION

Scale: NTS

TRUE NORTH PLAN NORTH

Project Number	21018
Drawn By	Author
Checked By	Checker
Approved By	Approver
Drawing Title	PROJECT INFORMATION
Drawing Number	A0.00

PROJECT LOCATION:

West side of Stadium Drive at Grace Point Drive, in Sugar Land TX. Mailing Address TBD.

PROJECT DESCRIPTION:

Single Story, 25,136 sq ft Precinct Annex for Fort Bend County Precinct 3. Metal Framed Construction (Pre-Engineered Rigid Frames); fully sprinklered.

ZONING:

The site is zoned Planned Development (PD) and governed by Ordinance. See below.

APPLICABLE CODES & ORDINANCES:

2015 International Building Code (IBC)
2015 International Mechanical Code (IMC)
2015 International Plumbing Code (IPC)
2015 International Fire Code (IFC)
2014 National Electric Code (NEC)
2012 Texas Accessibility Standards (TAS)
Sugar Land Development Code, Codified through Ordinance No. 2248
Sugar Land Ordinance No. 2009 governing Planned Development (PD) zone at Imperial Ballpark District-Tract E.
(Codes marked with an asterisk, "*", are amended by Sugar Land Ordinance No. 2027).

CODE ANALYSIS:

I. USE & OCCUPANCY CLASSIFICATION (RE: 2015 IBC CHAPTER 3)

- Mixed Use, Non-Separated per 2015 IBC 508.3:
Type B (Business)
Type A-3 (Assembly) <-> Governs

Height Above Grade Plane: 75' allowable per 2015 IBC Table 504.3.
32'-5" provided as indicated in elevations & sections.
Stories Above Grade Plane: 3 stories allowable per 2015 IBC Table 504.4.
1 story provided.
Allowable Building Area: 56,000 sq ft per 2015 IBC Table 506.2, occupancy type A-3 with 100% sprinklers and single story.
25,136 sq ft provided.

II. GENERAL BUILDING HEIGHTS AND AREAS (RE: 2015 IBC CHAPTER 5)

- Type II-B:
Height Above Grade Plane: 75' allowable per 2015 IBC Table 504.3.
32'-5" provided as indicated in elevations & sections.
Stories Above Grade Plane: 3 stories allowable per 2015 IBC Table 504.4.
1 story provided.
Allowable Building Area: 56,000 sq ft per 2015 IBC Table 506.2, occupancy type A-3 with 100% sprinklers and single story.
25,136 sq ft provided.

III. TYPES OF CONSTRUCTION (RE: 2015 IBC CHAPTER 6)

- For Type II-B Construction, fire resistance ratings of building elements are per 2015 IBC Table 601:

Primary Structural Frame: 0 hrs.
Bearing Walls (Exterior & Interior): 0 hrs.
Nonbearing Exterior Walls: 0 hrs.
Nonbearing Interior Partitions: 0 hrs.
Floor Construction and associated secondary members: 0 hrs.
Roof Construction and associated secondary members: 0 hrs.

II. FINISH REQUIREMENTS:

Wall and Ceiling Finishes
Wall and Ceiling finishes at interior exit stairways, ramps, and passageways shall be Class 'B' or better in accordance with 2015 IBC Section 903.1.3.
All other Wall and Ceiling finishes on the project shall be Class 'C' or better in accordance with 2015 IBC Section 903.1.3.

Floor Finishes
All Floor Finishes shall be type I or II in accordance with 2015 IBC Section 804.4.
Construction Type IIB requires that materials installed on or embedded in floors comply with 2015 IBC Sections 805.1.1 thru 805.1.3. No combustible materials shall be used in floor construction.

III. FIRE PROTECTION SYSTEMS

Sprinklers:
Sprinkler System to create a 100% sprinklered type II-B building when completed.
The Design Team is responsible only for Building Permit; it is the responsibility of the Sprinkler Subcontractor to obtain all necessary Trade Permits. If engineered drawings of the sprinkler system are required by the Authority Having Jurisdiction, it is the responsibility of the Contractor to obtain engineered drawings and to submit to the City for trade permit.
Sprinkler System is required to meet allowable area of building as indicated above; additionally, it is required in Type A-3 Occupancies per 2015 IBC Section 903.2.1.3
Sprinkler System shall comply with 2015 IBC Section 903.3, and all applicable codes referenced therein (including but not necessarily limited to NFPA 13).
Refer to Fire Protection Drawings and Specifications for more information.

Portable Fire Extinguishers:
Portable Fire Extinguishers shall be provided in accordance with 2015 IBC Section 906.3 and NFPA 10. (Ordinary - moderate - Hazard Occupancy shall be considered).
Re: 2015 IBC Table 906.3(1) for portable fire extinguisher requirements. Extinguishers in the project are indicated in the Egress Plan, 29/A0.00.

Fire Alarm System
The Fire Alarm System shall comply with 2015 IBC Section 907 and all applicable codes referenced therein (including but not necessarily limited to NFPA 72).
The Design Team is responsible only for Building Permit; it is the responsibility of the Fire Alarm Subcontractor to obtain all necessary Trade Permits. Shop Drawings required by 2015 IBC Section 907.1.2 and submission of the drawings to the Authority Having Jurisdiction are the responsibility of the Contractor.
Refer to Fire Protection Drawings and Specifications for more information.

IV. MEANS OF EGRESS

Occupant Load Calculations:
Occupant Loads are calculated using Section 1004 of the 2015 IBC, table 1004.1.2: "Maximum Floor Area Allowances per Occupant". The Abbreviated Occupancy Types are as follows:
AF: Assembly with Fixed Seats, in accordance with Section 1004.4.....
AC: Accessory storage areas, mechanical equipment room.....300gs/occupant.
B: Business.....150gs/occupant.
CR: Court Room - No Fixed Seats.....40gs/occupant.

Egress Widths:
Egress Widths are calculated per Section 1005.3.2. Other Egress Components: 0.2" per occupant.
Refer to Code Legend on this sheet for Total Egress Capacities per door.
Number of Exits:
Numbers of exits are calculated per Table 1006.2.1 and section 1006.2.2 of the 2015 IBC

V. PLUMBING FIXTURES

Occupant Load for Plumbing Count:
Load for Plumbing Fixture Count is calculated as follows:
Administration, Visitors and Staff of the Building : 356

Occupancy Classification: B

Occupants:	Total	Male	Female
	357	179	179

Male Waterclosets:	5	9
Female Waterclosets:	5	9
Male Lavatories:	4	8
Female Lavatories:	4	8
Bathubs or Showers:	0	1
Drinking Fountains:	4	2*
Other Requirements:	1 SERVICE SINK	Provided

* NOTE RE: DRINKING FOUNTAINS:
Per 2015 IPC section 410.4 (Substitution), "In Occupancies (other than restaurants) where drinking fountains are required, water dispensers shall be permitted to be substituted for not more than 50 percent of the required number of drinking fountains."
The building has five (5) break rooms, at least two of which will have a bottled water dispenser.

GENERAL

0	COVER SHEET
1	PROJECT INFORMATION
2	TAS INFORMATION
3	TAS INFO, & PTN TYPES
CIVIL	
1	GENERAL NOTES
2	CLEARING AND GRUBBING
3	PAVING PLAN
4	LAYOUT PLAN
5	GRAVING PLAN
6	UTILITY PLAN
7	DRAINAGE AREA MAP
8	SWPPP PLAN
9	PAVING DETAILS
10	C8.02 PAVING DETAILS
11	C8.03 SANITARY DETAILS
12	C10.01 STORM DETAILS
13	C10.02 STORM DETAILS
14	C11.00 WATER DETAILS
15	C12.00 SWPPP DETAILS

LANDSCAPE

1	L1.01	LANDSCAPE PLAN
2	L1.02	LANDSCAPE DETAILS
3	L2.01	IRRIGATION PLAN
4	L2.02	IRRIGATION DETAILS
STRUCTURAL FOUNDATION		
1	S1.01	GENERAL STRUCTURAL CRITERIA
2	S1.02	GENERAL STRUCTURAL CRITERIA
3	S2.01	FOUNDATION PLAN
4	S2.03	ROOF FRAMING PLAN
5	S3.01	STRAIGHT SHAFT SCHEDULE AND DETAILS
6	S4.01	TYPICAL FOUNDATION DETAILS
7	S4.02	PEMB DETAILS
8	S4.03	FOUNDATION DETAILS

STRUCTURAL PEMB

1	S1	STRUCTURAL AND MISCELLANEOUS STEEL
2	S2	ANCHOR ROD PLAN
3	S3	BRACING REACTIONS
4	S4	ROOF FRAMING PLAN
5	S5	SI DWALL FRAMING
6	S6	RIGID FRAME ELEVATION - FRAME LINE 3 9
7	S7	RIGID FRAME ELEVATION - FRAME LINE 4 8
8	S8	RIGID FRAME ELEVATION - FRAME LINE 5 7
9	S9	RIGID FRAME ELEVATION - FRAME LINE D F
10	S10	RIGID FRAME ELEVATION - FRAME LINE E
11	S11	RIGID FRAME ELEVATION - FRAME LINE 6
12	S11.1	RIGID FRAME REACTIONS
13	S12	RIGID FRAME ELEVATION - FRAME LINE X1 X2 X3 X4
14	S13	ENTRANCE ANCHOR ROD PLAN
15	S14	RIGID FRAME REACTIONS
16	S15	SI DWALL FRAMING LINE 6.15 AND 5.05
17	S16	ROOF FRAMING PLAN - ENTRANCE
18	S17	ENDWALL FRAMING FRAME LINES A 9
19	S18	RIGID FRAME ELEVATION - FRAME LINE A 9
20	S19	WIND BENT ELEVATION FRAME LINE 1 11
21	S20	WIND BENT ELEVATION - FRAME LINE C
22	S21	WIND BENT ELEVATION - FRAME LINE G
23	S22	DETAILS
24	S23	DETAILS

ARCHITECTURAL

1	A1.00	SITE PLAN
2	A1.10	ENLARGED SITE PLAN
3	A1.20	SITE DETAILS
4	A2.00	FLOOR PLAN
5	A2.10	REFLECTED CEILING PLAN
6	A2.20	ROOF PLAN
7	A2.35	ENLARGED RESTROOMS
8	A3.00	ELEVATIONS
9	A4.00	BUILDING SECTIONS
10	A4.01	WALL SECTIONS
11	A4.10	EXTERIOR WALL DETAILS
12	A5.00	DOOR SCHEDULE & DETAILS
13	A6.00	FINISH PLAN
14	A6.10	VIGNETTES & COURTCOURT
15	A6.50	MILLWORK ELEVATIONS & DETAILS

MEP SITE

1	MEP1.00	SITE PLAN
MECHANICAL		
1	M0.00	SYMBOLS, NOTES, & LEGENDS
2	M1.01	SCHEDULES
3	M2.01	ZONING PLAN
4	M3.00	CONTROLS
5	M4.01	DETAILS
6	M4.02	DETAILS

ELECTRICAL

1	E0.00	NOTES AND LEGEND
2	E0.10	ONE LINE DIAGRAM
3	E0.11	PANEL SCHEDULES
4	E0.12	PANEL SCHEDULES
5	E2.01	FLOOR PLAN - POWER
6	E2.02	FLOOR PLAN - EQUIPMENT
7	E3.01	FLOOR PLAN - LIGHTING
8	E4.01	FLOOR PLAN - FIRE ALARM
9	E5.01	DETAILS
10	E5.02	DETAILS

PLUMBING

1	P0.01	NOTES AND LEGEND
2	P0.02	FIXTURE SCHEDULE
3	P2.01	FLOOR PLAN - SANITARY
4	P3.01	FLOOR PLAN - DOMESTIC
5	P4.01	DETAILS
6	P5.01	RISER DIAGRAM - SANITARY
7	P5.02	RISER DIAGRAM - DOMESTIC

FIRE PROTECTION

1	FP1.01	FIRE PROTECTION PLAN AND NOTES
2	FP1.02	FIRE PROTECTION PLAN

1. STRUCTURAL ABBREVIATIONS

AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS	ELEC	ELECTRICAL	PLF	POUNDS PER LINEAR FOOT
ACI	AMERICAN CONCRETE INSTITUTE	ELEV	ELEVATOR	PLUMB	PLUMBING
ADDL	ADDITIONAL	EOD	EDGE OF DECK	PROJ	PROJECTION
ADJ	ADJACENT	EOS	EDGE OF SLAB	PSI	POUNDS PER SQUARE INCH
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION	EQ	EQUAL(LY)	PSF	POUNDS PER SQUARE FOOT
ASCE	AMERICAN SOCIETY OF CIVIL ENGINEERS	EW	EACH WAY	R	RIGHT, RISER, RADIUS
ASTM	AMERICAN SOCIETY OF TESTING MATERIALS	EXIST	EXIST	RD	ROOF DRAIN
AWS	AMERICAN WELDING SOCIETY	EXP	EXPANSION	REF	REFERENCE
BM	BEAM (MILD REINFORCE)	FF	FLOOR DRAIN	REF	REFERENCE
BC	BOTTOM CHORD	F.F.E.	FINISH FLOOR ELEVATION	REIN	REINFORCEMENT (D), (NG), (MENT)
BLDG	BUILDING	FND	FOUNDATION	REQD	REQUIRED
BOD	BOTTOM OF DECK	FS	FAR SIDE	REV	REVISION
BOT	BOTTOM	FT	FEET, FOOT	RH	RIGHT HAND
BT	BASE PLATE	FTG	FOOTING	RO	ROUGH OPENING
BRG	BEARING	GA	GAUGE	S	SOUTH, SLAB
BPL	BENT PLATE	GALV	GALVANIZED	SCHED	SCHEDULE(D)
BS	BOTH SIDES	GB	GRADE BEAM	SDI	STEEL DECK INSTITUTE
C	CHANNEL COMPRESSION	HORIZ	HORIZONTAL	SECT	SECTION
CAMB	CAMBER	HP	HIGH POINT	SF	SQUARE FEET
GIP	CAST IN PLACE	HR	HOUR	SHT	SHEET
CL	CENTER LINE	HSS	HOLLOW STRUCTURAL SECTION	SM	SIMILAR
CLR	CLEAR	ID	INSIDE DIAMETER	SJI	STEEL JOIST INSTITUTE
COL	COLUMN	IN	INCHES	SL	SLOPE
CONC	CONCRETE	INT	INTERIOR	SPA	SPACE
CONT	CONTINUOUS	JT	JOINT	SPC(S)	SPECIFICATION(S)
CPL	CAP PLATE	K	KIPS, JOIST SERIES	SQ	SQUARE
CS	CARBON STEEL	KB	KNEE BRACE	SQ	SQUARE
CSJ	CONSTRUCTION JOINT	L	SPAN, LEFT, STEEL ANGLE	STD	STANDARD
CTJ	CONTROL JOINT	LD	DEVELOPMENT LENGTH	STF	STIFFENER
D	DEPTH	LG	LENGTH, LONG	STR	STIRRUP
DET	DETAIL	LH	LEFT HAND	STL	STEEL
DF	DRILLED FOOTING	LL	LEVEL LOAD	STR	STRUCTURAL
DIA	DIAMETER	LLB	LONG LEG BACK TO BACK	T	TOP, TENSION
DIAG	DIAGONAL	LLH	LONG LEG HORIZONTAL	T & B	TOP & BOTTOM
DIM	DIMENSION	LV	LONG LEG VERTICAL	T & G	TONGUE AND GROOVE
DL	DEAD LOAD	LP	LOW POINT	TEMP	TEMPERATURE
DN	DOWN	LW	LONG WAY	THK	THICKNESS
DO	DITTO	MATL	MATERIAL	TOC	TOP OF CONCRETE
DWG	DRAWING	MAX	MAXIMUM	TOP	TOP OF FOOTING
DWL	DOWEL	MC	MOMENT CONNECTION, MISC CHANNEL	TOL	TOP OF LEDGE
E	EAST	MECH	MECHANICAL	TOP	TOP OF PANEL
EA	EACH	MF(S)	MANUFACTURER(S)	TOS	TOP OF STEEL
EF	EACH FACE	MID	MIDDLE	TOT	TOTAL
EJ	EXPANSION JOINT	MISC	MISCELLANEOUS	TOW	TOP OF WALL
EL	ELEVATION	MS	MILD STEEL	TRD(S)	TREAD(S)
		MSO	MASONRY OPENING	TQJ	TOP OF JOIST
		MT	STRUCTURAL TEE CUT FROM MISC STEEL	TYP	TYPICAL
		NORTH	NORTH	UL	UNDERWRITERS LABORATORY
		NO	NOT IN CONTRACT	UNF	UNIFORM
		NC	NUMBER	UN	UNLESS OTHERWISE NOTED
		NOM	NOMINAL	V	BEAM END SHEAR
		NTS	NOT TO SCALE	VB	VERTICAL BRACE
		OC	ON CENTER	VERT	VERTICAL
		OD	OUTSIDE DIAMETER	W	WALL, EST, WIDTH, WIDE FLANGE
		OPNG	OPENING	W	WITH
		OPP	OPPOSITE	WL	WIND LOAD, WATER LEVEL, WORKING LINE
		PL	PLATE	WP	WATER PROOF, WORKING POINT

2. STRUCTURAL LEGEND

P1	PRECAST CONCRETE PANEL	BEAM	CONNECTED TO A ROLLED SHAPE COLUMN WITH A STANDARD WELDED MOMENT CONNECTION STANDARD AISC ROLLED SHAPE BEAM
F1	SPREAD FOOTING MARK	10K1	STANDARD 'K' SERIES JOIST
P1	PLINTH MARK	JL	STEEL ANGLE BACK TO BACK
C1	COLUMN MARK	C	STANDARD ROLLED CHANNEL
CF1	CONTINUOUS WALL FOOTING MARK	□	HOLLOW STRUCTURAL SECTION
BW1	BASEMENT WALL MARK	○	STANDARD STEEL PIPE
RW1	RETAINING WALL MARK	Ø	DIAMETER
[BP1]	BASE PLATE MARK	#	NUMBER (BAR SIZE)
A	STRUCTURAL STEEL COLUMN SPLICE TYPE	□	SQUARE
2x8	STRAIGHT SHAFT DRILLED PIER/FOOTING	2x8	SLAB DEPRESSION AND AMOUNT
B1 GB1 1B1	MILD REINFORCED CONCRETE BEAM MARK	DATUM RE: PLAN	ELEVATION OF DATUM
J1	MILD REINFORCED CONCRETE JOIST MARK	DIM	DIMENSION TO FACE, COLUMN GRID OR CENTER LINE
DECK	SPAN DIRECTION OF A MILD REINFORCED CONCRETE SLAB WITH MAIN REINFORCING MARK S1	15°	ANGLE IN DEGREES, MINUTES AND SECONDS
DECK	SPAN DIRECTION OF 5 1/2" THICK CONCRETE SLAB W/ TYPE 1 STEEL DECK	1	REVISION MARK
DECK	SPAN DIRECTION OF A BARE STEEL DECK TYPE 2 WITH NO CONCRETE TOPPING	SECTION OR DETAIL REFERENCE (DRAWN AS DETAIL 1 ON SHEET S101)	
20KSP	SPECIAL OPEN WEB 'K' SERIES STEEL JOIST, SEE PLAN NOTES FOR LOADING REQUIREMENTS	3101	
W27X84 <24'-0">	STANDARD AISC ROLLED SHAPE OF W27X84 AT ELEVATION 24'-0" FROM DATUM	SECTION OR DETAIL REFERENCE (DRAWN AS DETAIL 1 ON SHEET S101)	
W27X84 <2 1/2">	STANDARD AISC ROLLED SHAPE OF W27X84 AT 2 1/2" FROM LEVEL ELEVATION		
W27X84 c=1"	STANDARD AISC ROLLED SHAPE OF W27X84 WITH 1" UPWARD CAMBER		
W27X84 c=1"	STANDARD AISC ROLLED SHAPE OF W27X84 WITH 20 KIPS BEAM END SHEAR		
20K			
W27X84 (10)	STANDARD AISC ROLLED SHAPE OF W27X84 WITH 10 HEADED SHEAR CONNECTORS EQUALLY SPACED		
W27X84 (10, 6, 12)	STANDARD AISC ROLLED SHAPE OF W27X84 WITH 10 HEADED SHEAR CONNECTORS EQUALLY SPACED FROM LEFT TO RIGHT AS 10 CONNECTORS / 6 CONNECTORS / 12 CONNECTORS		

3. STRUCTURAL CONCEPT, STANDARDS AND LOADS

A. DESIGN CONCEPT:

THE STRUCTURE AS SHOWN HAS BEEN DESIGNED IN ACCORDANCE WITH THE BUILDING CODE REQUIREMENTS AND DESIGN STANDARDS TO SUPPORT THE FINAL BUILDING SERVICE LOADS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ADDITIONAL SUPPORTS FOR THE STRUCTURE IF NECESSITATED BY THE CONSTRUCTION SEQUENCE OR METHODS OF FABRICATION, HANDLING, ERECTION, AND OTHER CONSTRUCTION OPERATIONS.

B. BUILDING CODES AND DESIGN STANDARDS:

- INTERNATIONAL BUILDING CODE, 2015 EDITION.
- AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE), MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES, ASCE 7-10, AS AMENDED.
- AMERICAN CONCRETE INSTITUTE (ACI), BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE, ACI 318, AS AMENDED.
- AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC), MANUAL OF STEEL CONSTRUCTION, 14TH EDITION (LRFD), 2015, AS AMENDED.
- AMERICAN WELDING SOCIETY (AWS).
- STEEL JOIST INSTITUTE (SJI), STANDARD SPECIFICATIONS FOR OPEN WEB STEEL JOISTS AND JOIST GIRDERS.
- STEEL DECK INSTITUTE (SDI), DESIGN MANUAL FOR COMPOSITE DECKS, FORM DECKS, ROOF DECKS, AND CELLULAR METAL FLOOR DECK WITH ELECTRICAL DISTRIBUTION.
- AMERICAN IRON AND STEEL INSTITUTE (AISI), SPECIFICATION FOR THE DESIGN OF COLD FORMED STEEL STRUCTURAL MEMBERS, LATEST EDITION.

- GRAVITY LOADS:
SUPERIMPOSED LOADS ARE GIVEN IN POUNDS PER SQUARE FOOT (PSF).

BUILDING AREA	DEAD LOAD (PSF)	LIVE LOAD (PSF)
1. SLAB ON GRADE	0	100
2. OFFICES	10	65(1)
3. ROOF	20	20
4. MECHANICAL AREAS	10	150(1)

(1) INCLUDES AN ALLOWANCE OF 15 PSF FOR PARTITION WEIGHT
(2) EQUIPMENT WEIGHT IF LARGER

D. LATERAL DESIGN LOADS:

- WIND LOADS FOR AN ULTIMATE WIND SPEED OF 135 MPH (3 SECOND GUST, WITH EXPOSURE B AND A RISK CATEGORY II (ASCE 7-10 METHOD))
- COMPONENT AND CLADDING PRESSURES ARE AS FOLLOWS:

TYPE	TRIBUTARY AREA	PRESSURES (PSF)		
		CORNER	PERIMETER	FIELD
WALLS	10 FT 2	+43, -58	-	+43, -47
ROOF	10 FT 2	+19, -119	+19, -79	+19, -47
PARAPET	10 FT 2	-	-	-
WALLS	100 FT 2	+37, -45	-	+37, -40
ROOF	100 FT 2	+16, -51	+16, -51	+16, -43
PARAPET	100 FT 2	-	-	-

- RE: **IBC 2015** FOR DESCRIPTION OF CORNER, PERIMETER & FIELD.
- POSITIVE PRESSURES ARE PRESSURES ACTING TOWARD THE BUILDING.
- NEGATIVE PRESSURES ARE PRESSURES ACTING AWAY FROM THE BUILDING.
- VALUES ABOVE ARE FOR ULTIMATE WIND PRESSURES. THE ASD FACTOR FOR NOMINAL PRESSURES IS 0.6.
- THE CORNER ZONE IS DEFINED AS ANY WALL DISTANCE WITHIN **10'-0"** OF ANY CORNER OF THE BUILDING (**ASCE 7-10**).

- WIND-BORNE DEBRIS REGION, USE RISK CATEGORY II WIND SPEED OF 135 MPH (ULTIMATE)

E. SEISMIC CRITERIA:

- IMPORTANCE FACTOR: 1.0
- RISK CATEGORY: II
- MAPPED SPECTRAL RESPONSE ACCELERATIONS: 0.07
a. S_s: 0.07
b. S₁: 0.037
- SITE CLASS: D
- SPECTRAL RESPONSE COEFFICIENTS:
a. S_{DS}: 0.075
b. S₁: 0.06
- SEISMIC DESIGN CATEGORY: A
- BASIC SEISMIC FORCE-RESISTING SYSTEM: (STRUCTURAL STEEL SYSTEMS NOT SPECIFICALLY DESIGNED FOR SEISMIC RESISTANCE)
- DESIGN BASE SHEAR: 0.025W
- SEISMIC RESPONSE COEF. (C_s): 3.025
- RESPONSE MODIFICATION FACTOR (R): 3
- ANALYSIS PROCEDURE USED: (EQUIVALENT LATERAL FORCE PROCEDURE)

F. GROUND SNOW LOADS: 5 PSF

G. SPECIAL LOADS:

ITEM	REQUIRED CAPACITY
TREADS	300 POUNDS AT CENTER
TOP RAILS	50 PLF HORIZONTALLY
OTHER RAILS, FILLERS & CONNECTIONS	50 PSF HORIZONTALLY
HAND RAILS	200 POUNDS ANY DIRECTION

SIZE	WEIGHT MAX.	SPACING OF HANGERS
4" DIA.	17 PLF	10'-0"
6" DIA.	32 PLF	10'-0"
8" DIA.	50 PLF	10'-0"
10" DIA.	75 PLF	5'-0"
12" DIA.	102 PLF	5'-0"

VALUES ASSUME SCHEDULE 40 STEEL PIPE

H. WIND STORM CRITERIA:

- BUILDING TYPE: OFFICE
- NOMINAL WIND SPEED 105 MPH (3 SECOND GUST), EXPOSURE C
- COUNTY: FORT BEND
- BUILDING CODE: IBC 2015 w/ TEXAS REVISIONS

4. GENERAL NOTES FOR CONSTRUCTION

A. CONSTRUCTION METHODS, PROCEDURES AND SEQUENCES ARE THE RESPONSIBILITY OF THE CONTRACTOR AND THE CONTRACTOR SHALL TAKE ALL THE NECESSARY MEANS TO MAINTAIN AND PROTECT THE STRUCTURAL INTEGRITY OF ALL CONSTRUCTION AT ALL STAGES.

B. THESE NOTES APPLY TO STRUCTURAL DOCUMENTS SEALED BY THE STRUCTURAL ENGINEER AND ARE INTENDED TO BE COMPLEMENTARY TO AND USED IN CONJUNCTION WITH THE PLANS AND SPECIFICATIONS, INCLUDING THOSE PREPARED BY OTHER DISCIPLINES. CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ARCHITECT/STRUCTURAL ENGINEER IMMEDIATELY. ANY SUCH DISCREPANCIES SHALL BE RESOLVED TO THE MORE STRINGENT REQUIREMENTS, UNLESS OTHERWISE AUTHORIZED BY THE STRUCTURAL ENGINEER.

C. ANY DISCREPANCIES ON THE STRUCTURAL DOCUMENTS SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE ARCHITECT/STRUCTURAL ENGINEER PRIOR TO SUBMISSION OF BIDS OR PROPOSALS, OR IF NOT REASONABLY DISCOVERABLE DURING PREPARATION OF BIDS AND PROPOSALS, BEFORE COMMENCING THE WORK IN QUESTION. NO FIELD CHANGES OR DIVIATIONS FROM THE DESIGN ARE TO BE MADE WITHOUT PRIOR WRITTEN APPROVAL OF THE ARCHITECT AND/OR STRUCTURAL ENGINEER. NO CHANGE ORDER CONSIDERATION WILL BE GIVEN TO CHANGES FOR WHICH THE ARCHITECT AND/OR ENGINEER WERE NOT CONTACTED PRIOR TO CONSTRUCTION OF THE AFFECTED ITEM.

D. CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONSTRUCTION, INCLUDING EXISTING WORK, PRIOR TO COMMENCING WORK. ANY DISCREPANCIES SHALL BE REPORT IMMEDIATELY TO THE ARCHITECT/STRUCTURAL ENGINEER.

E. ALL PROPOSED SUBSTITUTIONS MUST BE EQUAL OR BETTER AND SHALL BE REVIEWED BY THE ARCHITECT/ENGINEER PRIOR TO ANY PERTINENT WORK AND PRIOR TO THE AWARD OF THE CONTRACT.

F. NOT ALL OPENINGS AND OTHER COMPONENTS THAT ARE REQUIRED HAVE BEEN SHOWN IN THE STRUCTURAL DRAWINGS. COORDINATE WITH THE ARCHITECTURAL, MECHANICAL, PLUMBING AND ELECTRICAL DRAWINGS AND VERIFY THE LOCATIONS AND SIZES OF ALL CHASIS, RISERS, OPENINGS, SLEEVES, FINISHES, DEPRESSIONS, PADS AND OTHER PROJECT REQUIREMENTS. FLOOR PLAN WILL BE FURNISHED FOR THAT PURPOSE.

G. THE CONTRACTOR IS RESPONSIBLE FOR REVIEWING THE MECHANICAL, ELECTRICAL, PLUMBING AND ARCHITECTURAL DRAWINGS TO DETERMINE WHERE OPENINGS ARE REQUIRED IN REINFORCED CONCRETE BEAMS, SLABS AND WALLS.

H. THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS, DETAILING ALL THE OPENINGS, INCLUDING ADDED REINFORCEMENT AS SHOWN ON THE TYPICAL WALL, SLAB AND BEAM OPENING DETAILS FOR REVIEW.

I. ADDITIONAL REINFORCEMENT ABOVE THAT SHOWN IN THE TYPICAL SLAB AND BEAM OPENING DETAILS MAY BE REQUIRED AND WILL BE REVIEWED ON THE SHOP DRAWINGS.

J. USE THE MANUFACTURER'S CERTIFIED DRAWINGS AND SPECIFICATIONS FOR THE EQUIPMENT ANCHORAGE AND DETAILS.

K. ALL CONSTRUCTION JOINTS SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE INCORPORATED INTO THE STRUCTURE. ADDITIONAL CONSTRUCTION JOINTS TO FACILITATE CONSTRUCTION SHALL BE LOCATED AND DETAILED ON THE SHOP DRAWINGS FOR REVIEW.

L. HORIZONTAL CONSTRUCTION JOINTS SHALL NOT BE PERMITTED IN BEAMS UNLESS SHOWN ON THE STRUCTURAL DRAWINGS.

M. ALL CONSTRUCTION AND CONTROL JOINTS FOR BEAMS WHICH ARE EXPOSED TO WEAR ARE TO BE LOCATED TO COINCIDE WITH THE ARCHITECTURAL RUSTICATION JOINTS AS SHOWN ON THE BUILDING ELEVATION SHEETS OR AS REVIEWED IN WRITING.

N. SHOP DRAWINGS:

1. THE TERM "SHOP DRAWINGS" INCLUDES FABRICATION, MANUFACTURING, ERECTION AND SETTING DRAWINGS, BROCHURES, CERTIFICATES, AND PRODUCT DATA DESCRIBING MATERIALS AND EQUIPMENT. SHOP DRAWINGS SHALL INCLUDE ALL PERTINENT INFORMATION REQUIRED FOR THE ENGINEER TO FULLY EVALUATE THE MATERIALS BEING REPRESENTED BY THE SUBMITTAL INCLUDING THE PHYSICAL PROPERTIES, DIMENSIONS, LOCATIONS AND METHOD OF INSTALLATION.

2. SHOP DRAWINGS WILL BEAR THE REVIEW STAMP OF THE CONTRACTOR INDICATING THAT HE HAS REVIEWED THE DRAWINGS FOR CONFORMANCE WITH THE CONTRACT DOCUMENTS. COORDINATED ITEMS INCLUDED IN THE SUBMITTAL WITH RELATED ITEMS, AND VERIFIED AND COORDINATED DIMENSIONS.

3. REPRODUCTIONS OF THE ENGINEERING DRAWINGS WILL NOT BE ACCEPTABLE AS SHOP DRAWINGS.

4. ANY SHOP DRAWING NOT CONFORMING TO THESE REQUIREMENTS WILL BE CAUSE FOR REJECTION AND WILL BE RETURNED WITHOUT ANY FURTHER ACTION.

5. STRUCTURAL SUBMITTALS REQUIRED FOR APPROVAL INCLUDE, BUT ARE NOT LIMITED TO:

- CONCRETE ACCESSORIES (MANUFACTURERS PRODUCT DATA)
- STEEL REINFORCING
- CONCRETE MIX DESIGN
- CONTROL JOINT LAYOUT
- CONCRETE MATERIAL CERTIFICATES
- STRUCTURAL STEEL FRAMING
- STRUCTURAL STEEL CONNECTION CALCULATIONS
- STEEL ROOF DECK
- COLD FORMED METAL FRAMING
- COLD FORMED METAL FRAMING CALCULATIONS
- MISC. STEEL FABRICATIONS

O. DELEGATED STRUCTURAL DESIGN OF COMPONENTS:

A. SEE APPLICABLE SECTIONS OF GENERAL NOTES FOR THE APPROPRIATE DESIGN RESPONSIBILITIES OF THE SUPPLIER AND IT'S LICENSED ENGINEER

B. MAINTAIN PROPER SITE DRAINAGE DURING CONSTRUCTION SO THAT PONDING OF WATER DOES NOT OCCUR IN THE BUILDING AREA.

C. SUB-GRADE PREPARATION:

- PERFORM DEMOLITION OF EXISTING STRUCTURES AS REQUIRED BY THE GEOTECHNICAL REPORT. THE ENTIRE VOLUME OF THE EXCAVATIONS CREATED BY DEMOLITION AND REMOVAL OF EXISTING STRUCTURES SHOULD BE BACKFILLED WITH ENGINEERED (SELECT) FILL THAT IS PROPERLY PLACED AND COMPACTED.
- EXCAVATE EXISTING SOILS AS REQUIRED TO REMOVE ALL EXISTING VEGETATION, ROOTS AND DELETERIOUS MATERIALS FROM THE PROPOSED BUILDING AREA, AND AS REQUIRED BY GEOTECHNICAL REPORT. THE CLEARING SHOULD EXTEND BEYOND THE BUILDING EDGES. ONCE ROUGH GRADE IS ESTABLISHED, THE EXPOSED SURFACE SHOULD BE PROOF-ROLLED. ANY SOFT POCKETS OF SOFT OR WEAK SOILS ENCOUNTERED SHOULD BE REMOVED. BUILD BUILDING PAD AS REQUIRED BY GEOTECHNICAL REPORT.
- BUILDING PAD UNDER SLAB ON GRADE SHALL BE PREPARED TO PROVIDE AN OWNER APPROVED P.V.R. OF 1" OR LESS BASED ON RECOMMENDATIONS IN THE PROJECT GEOTECHNICAL REPORT.

D. FOUNDATIONS FOR STRAIGHT SHAFT DRILLED PIERS HAVE BEEN DESIGNED PER GEOTECHNICAL REPORT.

E. REFER TO THE GEOTECHNICAL EXPLORATION FOR ADDITIONAL INFORMATION.

5. CONCRETE

A. CONCRETE SCHEDULE:

BUILDING COMPONENT	28 DAY CYLINDER COMPRESSIVE STRENGTH (POUNDS PER SQUARE INCH)(PSI)				SLUMP (IN)	W/C RATIO
	NORMAL WEIGHT	MAX	AGGREGATE	SIZE (IN)		
1. DRILLED PIERS	3000	3500	4000	1 1/2"	5.7	0.55
2. SLAB-ON-GRADE	●	●	●	1"	4.6	0.50
3. SLAB-ON-DECK	●	●	●	1"	4.6	0.50
4. GRADE BEAMS AND PLINTHS	●	●	●	1"	4.6	0.50
5. ALL OTHER CONCRETE	●	●	●	1"	4.6	0.52

1. PROVIDE DEFORMED MILD BILLET STEEL BARS CONFORMING TO ASTM A616, GRADE 60. ALL REINFORCING STEEL SHALL BE SECURELY HELD IN PLACE; PROVIDE ADDITIONAL BARS OR STRUTS FOR SUPPORT AS REQUIRED.

2. WELDED WIRE FABRIC SHALL CONSIST OF FLAT SHEETS AND SHALL CONFORM TO ASTM A185, WITH A MINIMUM YIELD STRENGTH OF 65 KSI.

3. PROVIDE FULL EMBEDMENT WITH STANDARD 90 DEGREE HOOKS FOR ALL DOWELS. IF NOT OTHERWISE SPECIFIED, THE DOWEL SIZE AND SPACING SHALL BE THE SAME AS THE MAIN REINFORCING.

4. WHEN REINFORCING STEEL IN GRADE BEAMS, WALLS, SLABS AND BEAMS, IS NOTED AS CONTINUOUS, SPLICE REINFORCING STEEL ONLY WHEN UNAVOIDABLE DUE TO STOCK LENGTHS. STAGGER ALL SPLICES A MINIMUM OF 4'-0" ADJACENT BARS SPLICES ARE NOT ACCEPTABLE.

5. LOCATE THE TOP BAR SPLICES WITHIN THE MIDDLE HALF OF THE SPAN AND LOCATE THE BOTTOM BAR SPLICES AT SUPPORTS OR BETWEEN SUPPORTS AND 1/3 SPAN POINT, UNLESS NOTED OTHERWISE ON PLANS, DETAILS OR SCHEDULES.

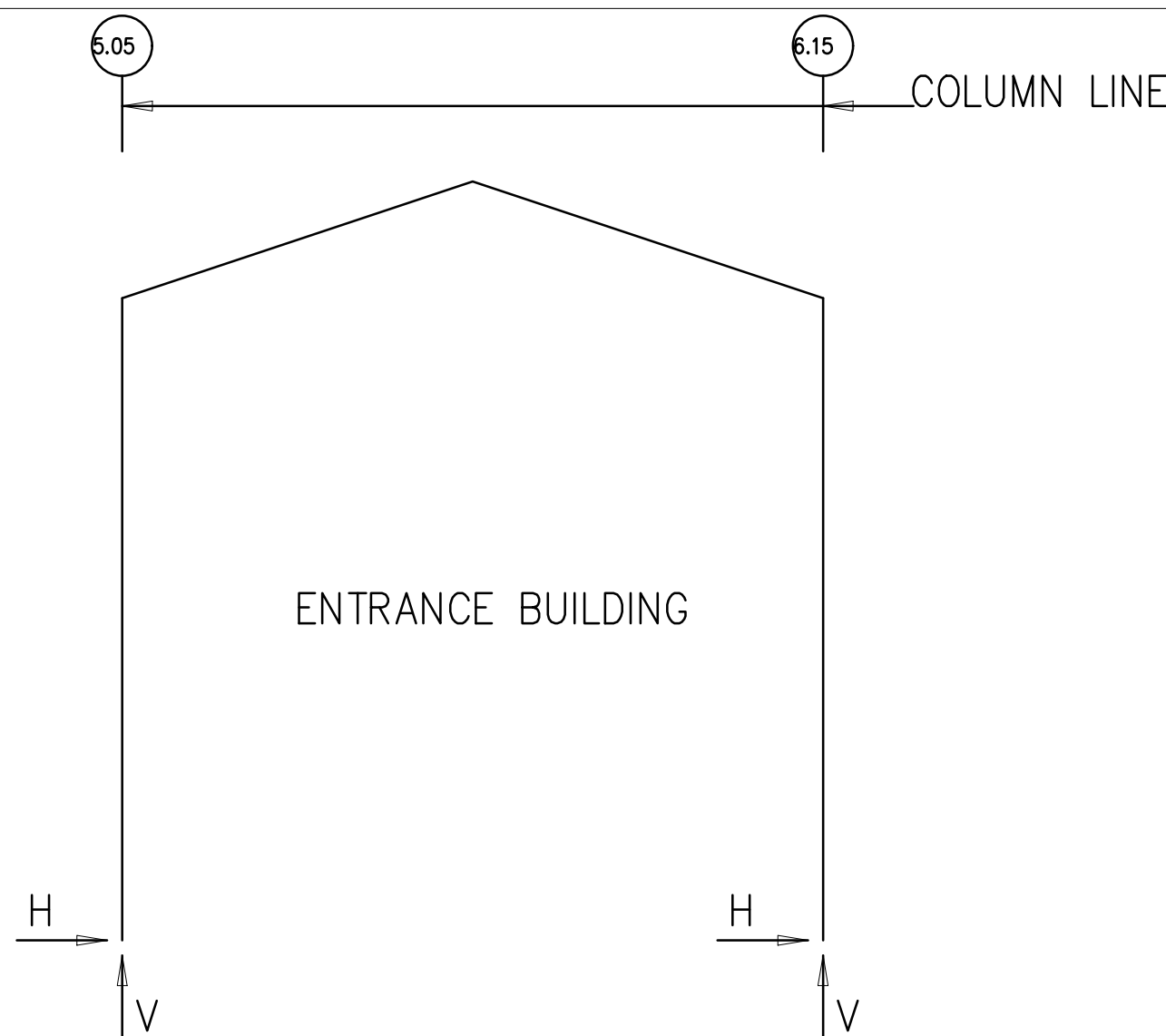
6. PROVIDE INTERIOR AND EXTERIOR HORIZONTAL LAPPED CORNER BARS AT ALL CORNERS TO MATCH THE SIZE, TYPE AND SPACING OF THE WALL AND GRADE BEAM HORIZONTAL REINFORCING.

7. UNLESS SPECIFICALLY NOTED, SCHEDULED OR DETAILED OTHERWISE, PROVIDE DEVELOPMENT LENGTH FOR REINFORCING IN CONCRETE COMPONENTS IN ACCORDANCE WITH THE SCHEDULE IN NOTE H BELOW. THIS SCHEDULE SHALL APPLY TO ALL DEVELOPMENT LENGTHS NOT OTHERWISE NOTED, DETAILED OR SCHEDULED IN THE DRAWINGS OR SPECIFICATIONS.

8. REINFORCING BAR DEVELOPMENT LENGTHS (L_d) IN INCHES FOR VARIOUS CONCRETE STRENGTHS IN POUNDS PER SQUARE INCH (PSI). TOP BARS ARE DEFINED AS HORIZONTAL REINFORCING SO PLACED IN A MEMBER THAT MORE THAN 12 INCHES OF CONCRETE IS CAST BELOW THE BAR. ALL OTHER CONDITIONS ARE CONSIDERED BOTTOM BARS FOR DEVELOPMENT AND SPLICE LENGTH PURPOSES.

BAR SIZE GRADE 60	L _d FOR TOP BARS				L _d FOR BOTTOM BARS			
	28 DAY CYLINDER CONCRETE STRENGTH (PSI)				28 DAY CYLINDER CONCRETE STRENGTH (PSI)			
	3000/3500	4000	5000	6000	3000/3500	4000	5000	6000
#3	22	19	17	16	17	15	13	12
#4	29	25	23	21	22	19	17	16
#5	36	31	28	26	28	24	22	20
#6	43	37	34	31	33	29	26	24
#7	51	43	40	36	40	34	30	28
#8	59	50	46	42	46			

FRAME LINES: A A.9



NOTES FOR REACTIONS

ENTRANCE BUILDING

Building reactions are based on the following building data:

Width (ft)	=	30.0
Length (ft)	=	25.0
Eave Height (ft)	=	25.84/ 25.84
Roof Slope (rise/12)	=	4.0/ 4.0
Dead Load (psf)	=	5.0
Collateral Load (psf)	=	8.0
Roof Live Load (psf)	=	20.0
Frame Live Load (psf)	=	12.0
Wind Speed (mph)	=	139.0
Wind Code	=	IBC 18
Exposure	=	B
Closed/Open	=	C
Importance Wind	=	1.00
Importance Seismic	=	1.00
Seismic Zone	=	A

RIGID FRAME: MAXIMUM REACTIONS, ANCHOR RODS, & BASE PLATES

Frm Line	Col Line	Column_Reactions(k)						Bolt(in) Qty	Dia	Base_Plate(in)			Grout (in)
		Load Id	Hmax H	V Vmax	Load Id	Hmin H	V Vmin			Width	Length	Thick	
A	5.05	2	6.7	6.7	7	-7.5	-5.6	4	0.750	10.00	13.00	0.500	0.0
		4	4.3	14.5	5	-5.4	-9.4						
A	6.15	8	7.6	-5.6	1	-6.7	6.7	4	0.750	10.00	13.00	0.500	0.0
		3	-4.3	14.5	6	5.4	-9.4						

RIGID FRAME: MAXIMUM REACTIONS, ANCHOR RODS, & BASE PLATES

Frm Line	Col Line	Column_Reactions(k)						Bolt(in) Qty	Dia	Base_Plate(in)			Grout (in)
		Load Id	Hmax H	V Vmax	Load Id	Hmin H	V Vmin			Width	Length	Thick	
A.9	5.05	2	7.0	5.9	7	-7.8	-6.1	4	0.750	10.00	13.00	0.500	0.0
		4	5.0	21.2	5	-5.4	-12.9						
A.9	6.15	8	7.8	-6.1	1	-7.0	5.9	4	0.750	10.00	13.00	0.500	0.0
		3	-5.0	21.1	6	5.4	-12.9						

ENDWALL COLUMN: BASIC COLUMN REACTIONS (k)

Frm Line	Col Line	Dead Vert	Wind Press Horz	Wind Suct Horz	Seis Long Vert
A	6	0.1	-2.7	2.9	0.0

ENDWALL COLUMN: MAXIMUM REACTIONS, ANCHOR BOLTS, & BASE PLATES

Frm Line	Col Line	Column_Reactions(k)						Bolt(in) Qty	Dia	Base_Plate(in)			Grout (in)
		Load Id	Hmax H	V Vmax	Load Id	Hmin H	V Vmin			Width	Length	Thick	
A	6	9	1.7	0.0	10	-1.6	0.0	2	0.625	3.500	10.00	0.375	192.0
		11	1.7	0.1									

RIGID FRAME: BASIC COLUMN REACTIONS (k)

Frame Line	Column Line	---Dead---		---Collateral---		---Live---		---Wind_Left1---		---Wind_Right1---		---Wind_Left2---	
		Horiz	Vert	Horiz	Vert	Horiz	Vert	Horiz	Vert	Horiz	Vert	Horiz	Vert
A	5.05	0.2	3.8	0.3	3.3	0.4	5.0	-9.2	-19.4	9.6	0.9	-12.8	-13.1
A	6.15	-0.2	3.8	-0.3	3.3	-0.4	5.0	-9.6	0.9	9.2	-19.4	-8.0	8.2
A.9	5.05	0.3	5.5	0.5	5.9	0.6	9.0	-9.3	-26.9	8.8	-6.6	-13.3	-15.6
A.9	6.15	-0.3	5.5	-0.5	5.9	-0.6	9.0	-8.8	-6.6	9.3	-26.9	-8.3	6.6

Frame Line	Column Line	---Wind_Right2---		---Wind_Long1---		---Wind_Long2---		---Seismic_Left---		---Seismic_Right---		---Wind_Left3---	
		Horiz	Vert	Horiz	Vert	Horiz	Vert	Horiz	Vert	Horiz	Vert	Horiz	Vert
A	5.05	8.0	8.3	5.7	-12.6	3.6	0.3	-0.3	-0.6	0.3	0.6	-10.1	-16.1
A	6.15	12.8	-13.1	-5.7	-12.6	-3.6	0.3	-0.3	0.6	0.3	-0.6	-10.9	4.9
A.9	5.05	8.3	6.7	5.0	-22.6	3.6	0.6	-0.5	-0.9	0.5	0.9	-11.0	-20.9
A.9	6.15	13.3	-15.6	-5.0	-22.6	-3.6	0.6	-0.5	0.9	0.5	-0.9	-11.1	0.7

Frame Line	Column Line	---Wind_Right3---		---Wind_Left4---		---Wind_Right4---	
		Horiz	Vert	Horiz	Vert	Horiz	Vert
A	5.05	10.9	4.9	-12.2	-14.5	6.9	5.5
A	6.15	10.1	-16.1	-6.9	5.4	12.2	-14.5
A.9	5.05	11.1	0.7	-12.2	-18.0	6.4	1.7
A.9	6.15	11.0	-20.9	-6.4	1.7	12.2	-18.0

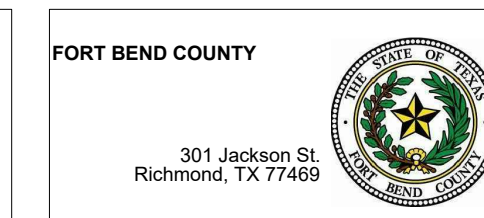
ID Description

- 1 Dead+0.6Wind_Left3
- 2 Dead+0.6Wind_Right3
- 3 Dead+Collateral+0.75Live+0.45Wind_Left2
- 4 Dead+Collateral+0.75Live+0.45Wind_Right2
- 5 0.6Dead+0.6Wind_Left1
- 6 0.6Dead+0.6Wind_Right1
- 7 0.6Dead+0.6Wind_Left2
- 8 0.6Dead+0.6Wind_Right2
- 9 0.6Dead+0.6Wind_Right2+0.6Wind_Suction
- 10 0.6Dead+0.6Wind_Pressure+0.6Wind_Long2L
- 11 Dead+0.6Wind_Right2+0.6Wind_Suction

BUILDING BRACING REACTIONS

Loc	Wall Line	Col Line	± Reactions(k)				Panel_Shear (lb/ft)		Note
			Horz	Vert	Horz	Vert	Wind	Seis	
L_EW	A								(h)
F_SW	6.15								(B)
R_EW	A.9								(h)
B_SW	5.05								(B)

(h)Rigid frame at endwall
(B)Braced by main building



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Infrastructure Associates
(713) 622-0120
CIVIL ENGINEERS
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LANDSCAPE
Greenscape Associates
(281) 341-9985



FORT BEND COUNTY
PRECINCT 3 ANNEX

STADIUM DRIVE &
IMPERIAL BLVD
FORT BEND COUNTY, TX

#	Date	ISSUED FOR
A	11/11/2022	95% CD
B	01/05/2023	PERMIT

PE

BUILDINGS
BRIDGES
INSPECTIONS
MARINE STRUCTURES
CIVIL ENGINEERING &
STRUCTURAL ENGINEERING

PARAMOUNT
ENGINEERING LLC

10145 LONG POINT DR.
HOUSTON, TX 77043
TEL. : (713) 636-9977
FAX : (281) 888-9128
CEL. : (713) 204-1742

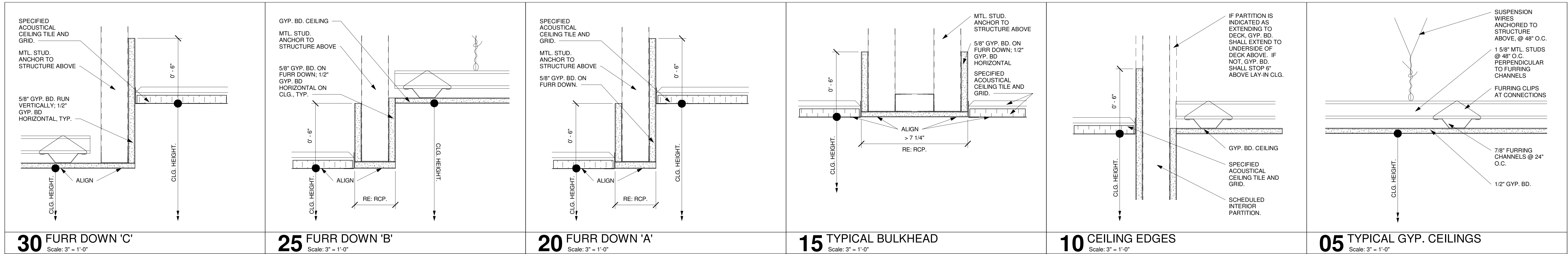
TBPE REGISTRATION # F-3394

DRAWN BY: FA CHECKED BY: MM

PROJ. NO.: PE22-303

Project Number	21018
Drawn By	Author
Checked By	Checker
Approved By	Approver

Drawing Number **S14**



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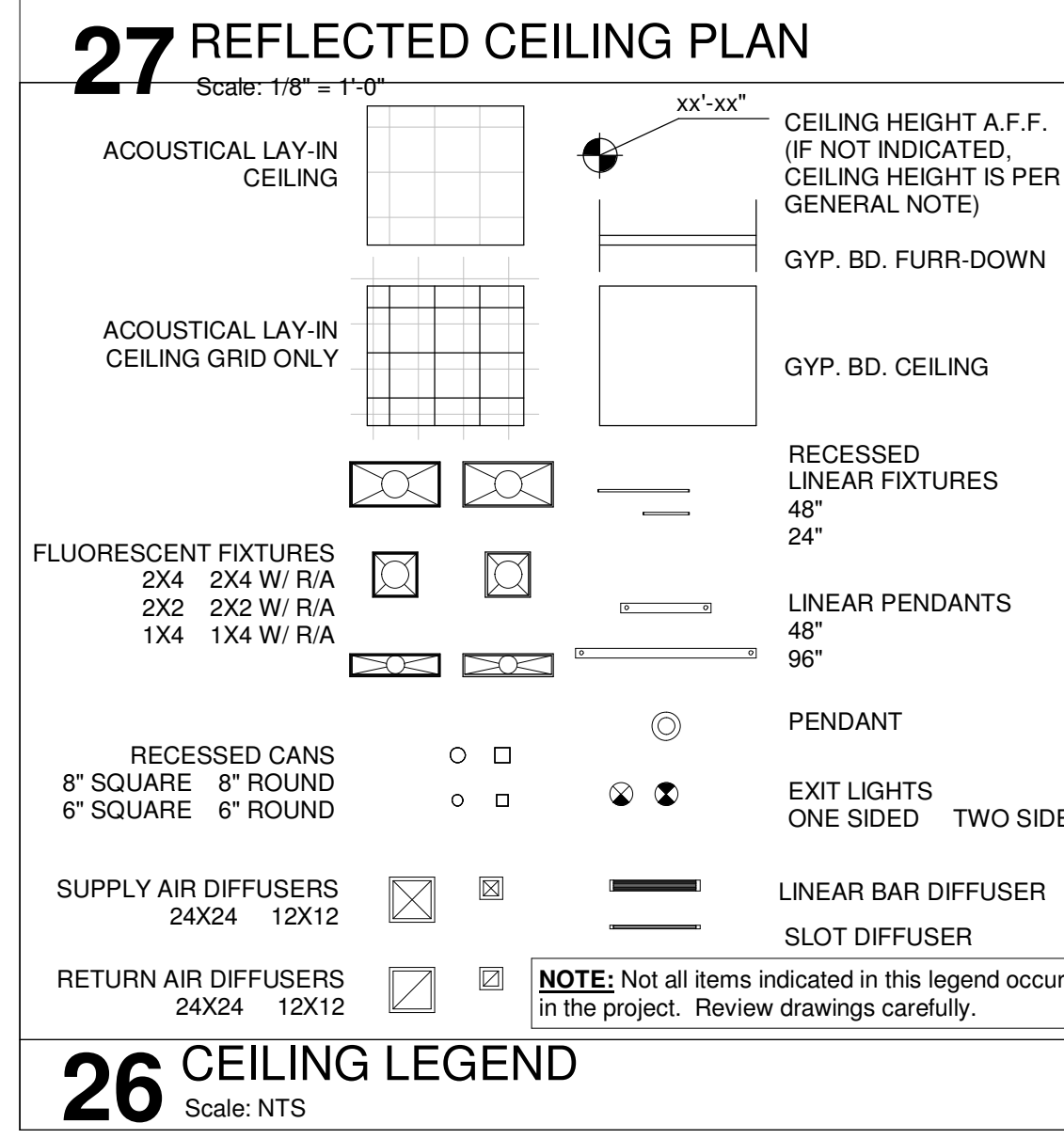


PROFESSIONAL SEAL:

 12/13/2022

FORT BEND COUNTY - PRECINCT 3 ANNEX
 STADIUM DRIVE & IMPERIAL BLVD
 FORT BEND COUNTY, TX

#	Date	ISSUED FOR BID, PERMIT, AND CONSTRUCTION
1	01/23/2023	



21 KEYNOTES
 Scale: NTS

C01 Gyp. Bd. Bulkhead: 1/2" Gyp. Bd. on 7/8" furring channels at 24" O.C. suspended from structure above.
 C02 Plaster Soffit: re: Building Sections.
 C03 Underside of perimeter gutter, re: Roof Plan.
 C04 Underside of Fiberglass Cornice, re: Roof Plan.
 C05 Open to structure above; 48" Chain-Hung linear LED fixtures in this space indicated for quantity only. Re: General Note 5.

11 SUPPORT NOTES
 Scale: NTS

Support Notes

Dimension & Alignment Support Notes:

(ALIGN 1)..... Align face of new construction w/face of existing.
 (ALIGN 2)..... Align centerline of new construction w/centerline of existing.
 (ALIGN 3)..... Align grid/main grid w/existing grid.
 (LEVEL 1)..... Ensure top of new construction is level w/existing surface.
 (LEVEL 2)..... Level floor & surface to receive new construction.
 (LEVEL 3)..... Ensure the top of grade is level w/surrounding ground.

Construction & Condition Support Notes:

(HANDLE 1)..... Handle item w/care, and store for owner review.
 (HANDLE 2)..... Handle remaining building, pavement, fences, or item w/care.
 (HANDLE 3)..... Handle re-located items with care. DISCONNECT 1, FIXW.
 (FIXW)..... Fix floor/wall/ceiling/item where construction was removed and prepare the area to receive new construction. Ensure the top of grade is level w/surrounding ground & maintain positive slope towards drain, gutter, and storm system away from building.
 (FIXI)..... Fix floor/wall/ceiling/item where construction was removed and prepare the area to receive new construction. Ensure the top of grade is level w/surrounding ground & maintain positive slope towards drain, gutter, and storm system away from building.
 (INFO1)..... Inform Architect prior to the start of this work.
 (CONNECT1)..... Connect new construction to existing, ensure continuity and structural integrity. Ensure the top of new construction is level w/existing surface.
 (CONNECT2)..... Connect remaining item to the new structure, and ensure structural integrity while meeting local Codes. Handle remaining buildings, pavement, fences, and other items w/care.

(DISCONNECT1) Disconnect and conceal all pipes, electrical cables, data cables, and conduits where construction is removed.
 (ENGINEER1)..... Professional engineering supervision is required for this work.
 (SHOP1)..... Provide shop drawings for this work.
 (REFERENCE)..... Refer to photo # for the existing condition at this location.
 (SLOPE1)..... Maintain positive slope towards drains, gutters, and storm systems and away from the building. Ensure maximum slope in all directions of 1:48 (2%) within accessible clearances; maximum 1:48 (2%) cross slope at sidewalks; maximum 1:20 (5%) running slope at sidewalks.
 (PROTECT1)..... Protect items to remain, including any buildings, furniture, sidewalks, roofs, utilities, and other items during the Demolition and Construction phases.
 (EGRESS)..... Maintain safe and unrestricted egress routes from areas adjacent to the Demolition site. Comply with all Applicable Codes.
 (OPERATE)..... Ensure all routes and utilities required for owner's use and operations on site are protected. Owner's use of site shall not be interrupted.
 (ENSURE1)..... Ensure all slopes to drain as intended, and that downspouts indicated to remain are protected to maintain normal flow at all times during demolition and construction. Protect items to remain including any buildings, furniture, sidewalks, roofs, utilities, and other items during demolition and construction.
 (ENSURE2)..... Ensure system is water-tight. Provide additional flashing & sealants as needed.
 (ENSURE3)..... Ensure the slope of the new roof matches the slope and slope direction of the existing roof.

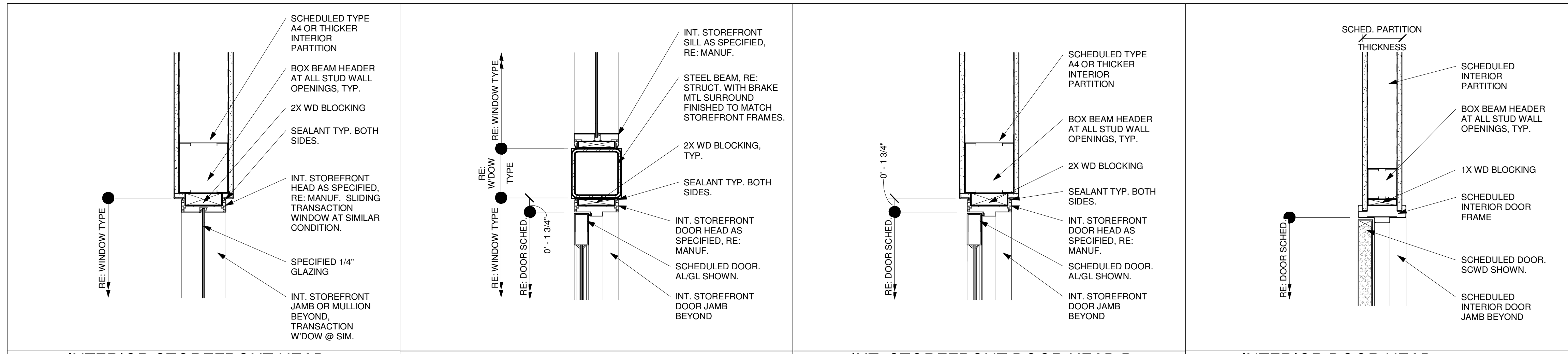
01 GENERAL CEILING NOTES
 Scale: NTS

General Notes refer to conditions that apply to the entire project.

- All Ceilings other than restroom ceilings shall be installed at 12'-0" AFF unless indicated otherwise.
- All restroom ceilings shall be installed at 9'-0" AFF.
- All light fixtures installed in gyp. bd. ceilings are to be centered in the room and evenly spaced unless indicated otherwise.
- All light fixtures and other equipment installed in acoustical ceilings is to be centered on a ceiling tile.
- Light fixtures installed in Mechanical and Electrical rooms are indicated for quantity only. Final locations shall be coordinated with equipment in field.
- Architectural RCPs indicate architectural lighting only. Refer to Electrical and Fire Protection drawings for emergency lighting, strobes, etc.
- Exterior soffits and underside of car drop canopy are to be 7/8" plaster on mtl lath. Refer to building sections for more information.

TRUE NORTH PLAN NORTH

Project Number	21018
Drawn By	Author
Checked By	Checker
Approved By	Approver
Drawing Title	REFLECTED CEILING PLAN
Drawing Number	A2.10

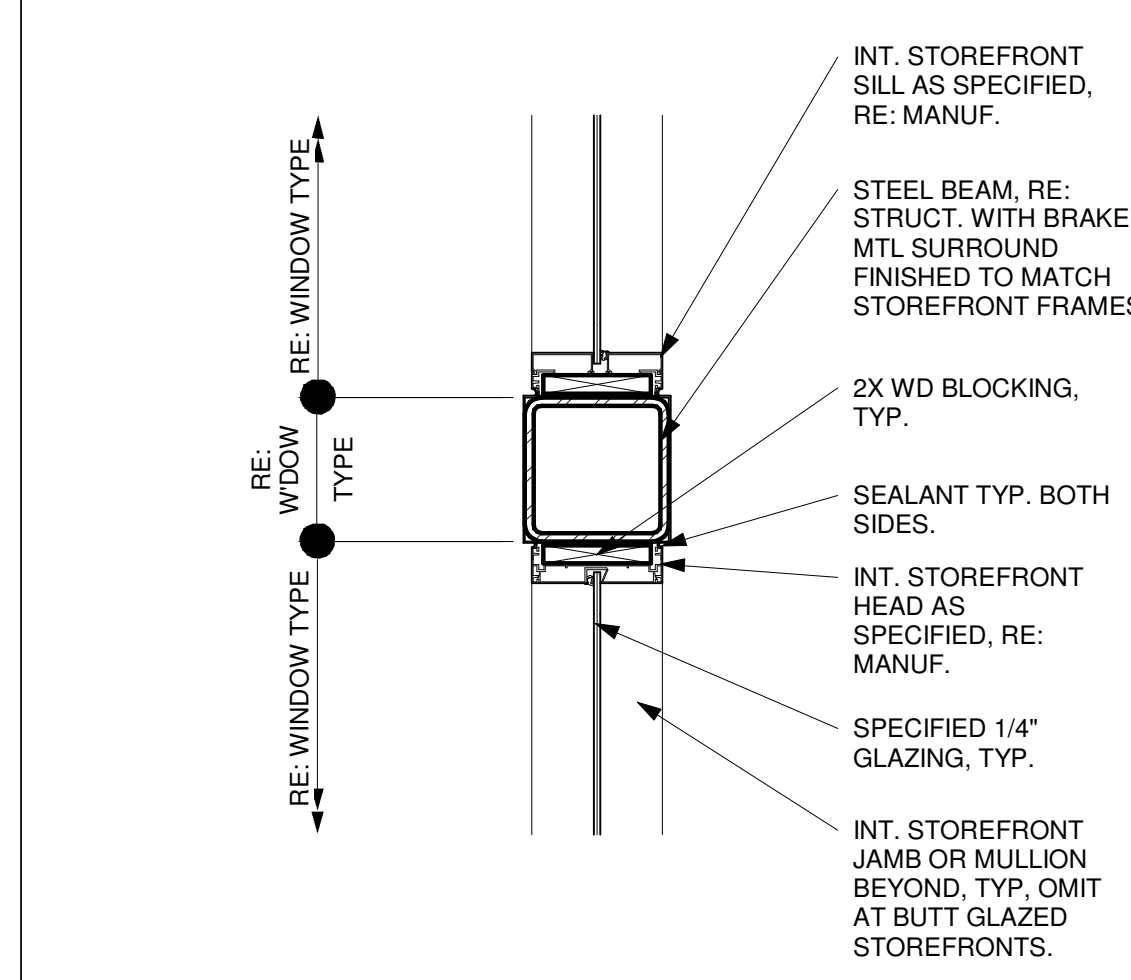


30 INTERIOR STOREFRONT HEAD
Scale: 1 1/2" = 1'-0"

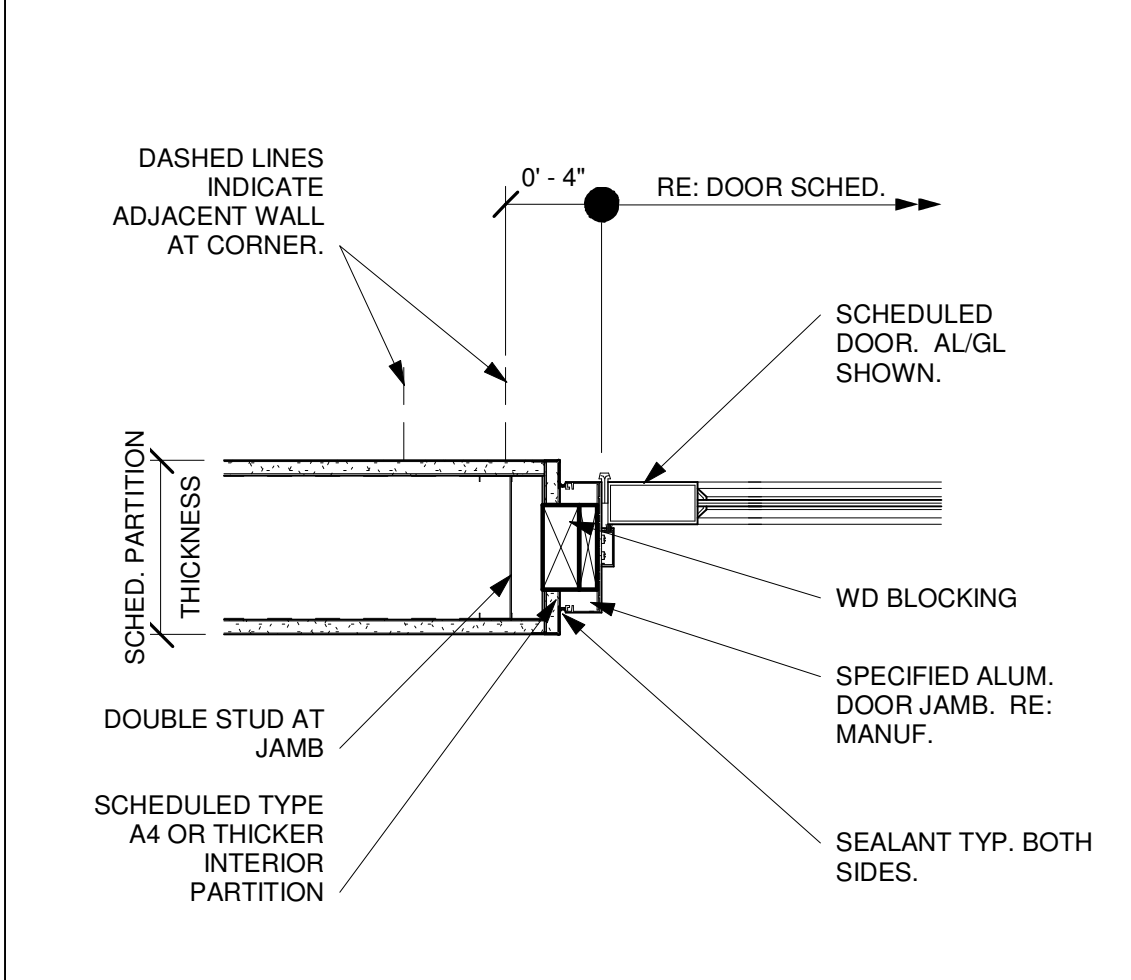
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Scale: 1 1/2" = 1'-0"

20 INT. STOREFRONT DOOR HEAD B
Scale: 1 1/2" = 1'-0"

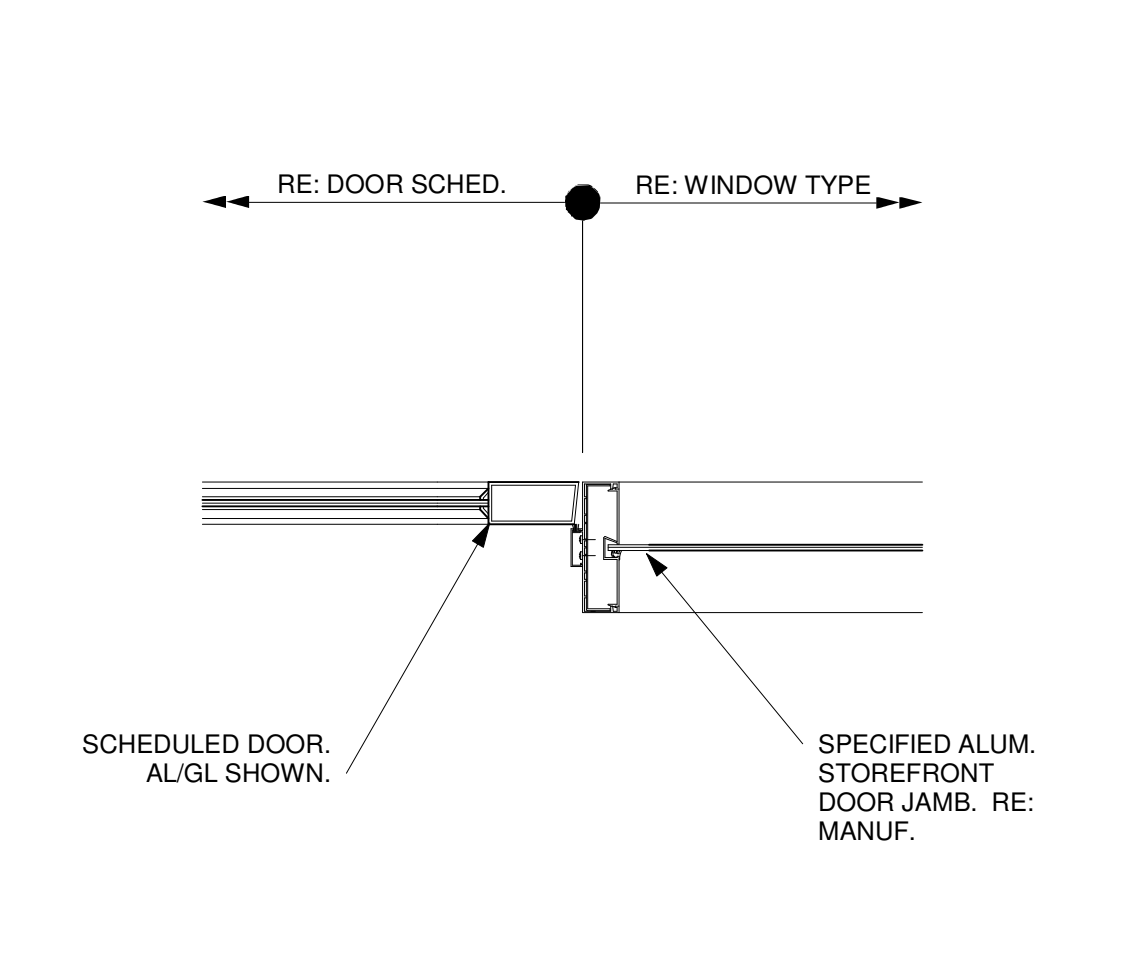
15 INTERIOR DOOR HEAD
Scale: 1 1/2" = 1'-0"



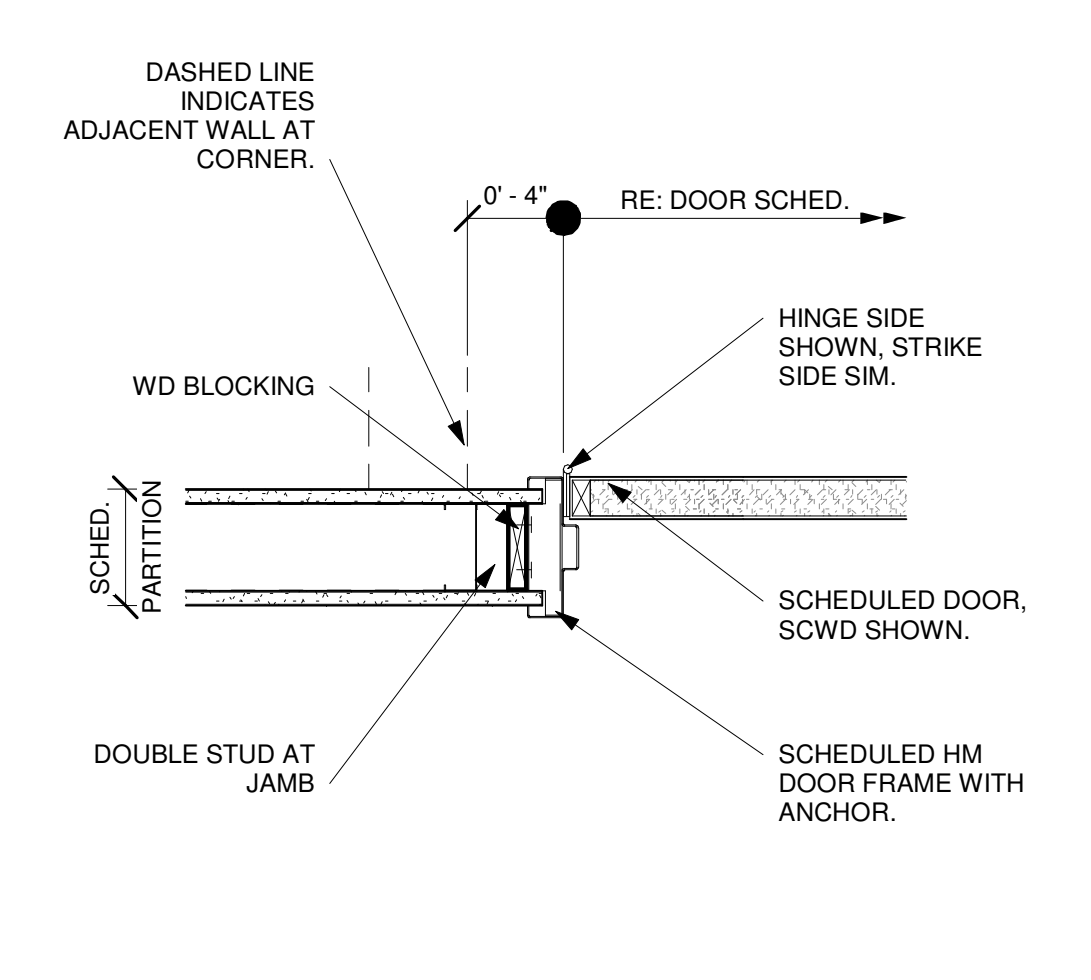
29 STEEL HEADER AT STOREFRONT
Scale: 1 1/2" = 1'-0"



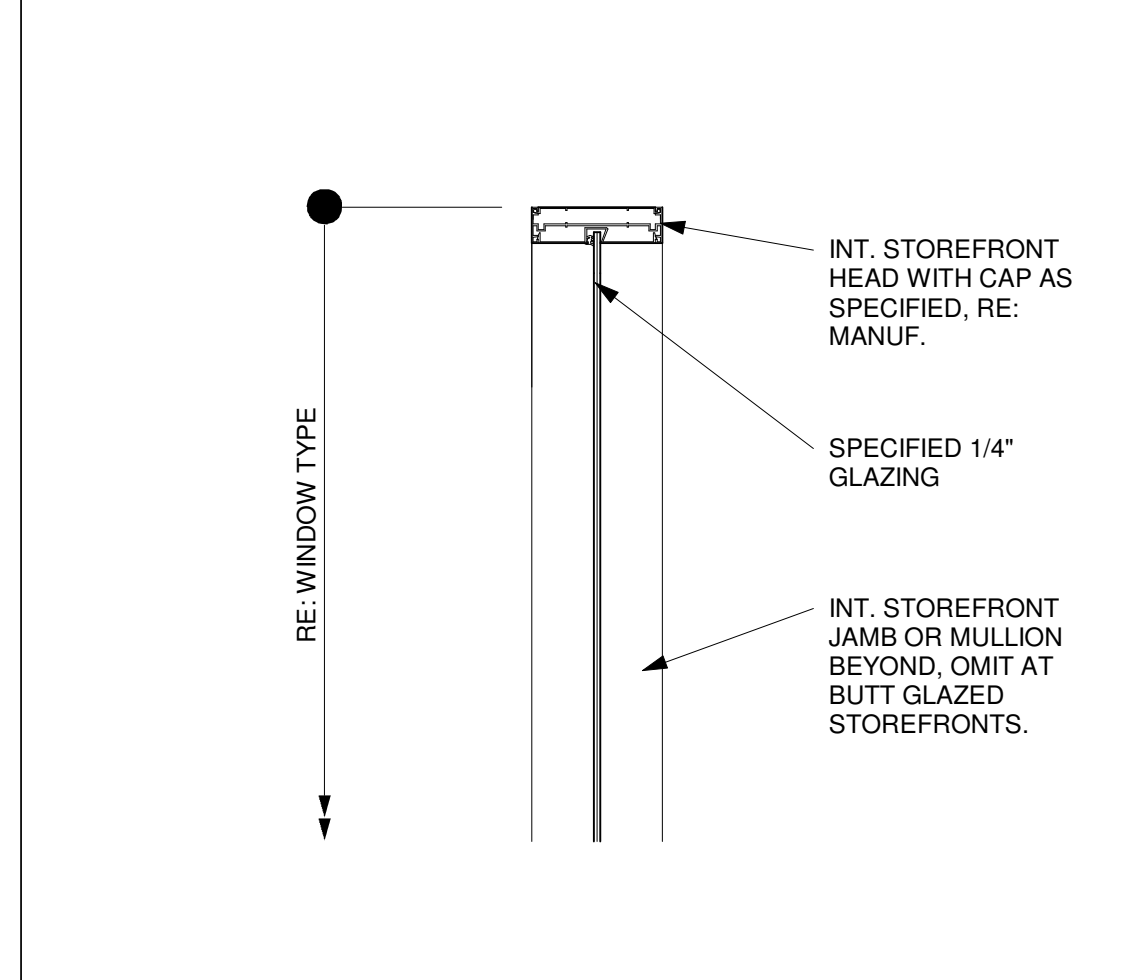
24 INT. STOREFRONT DOOR JAMB A
Scale: 1 1/2" = 1'-0"



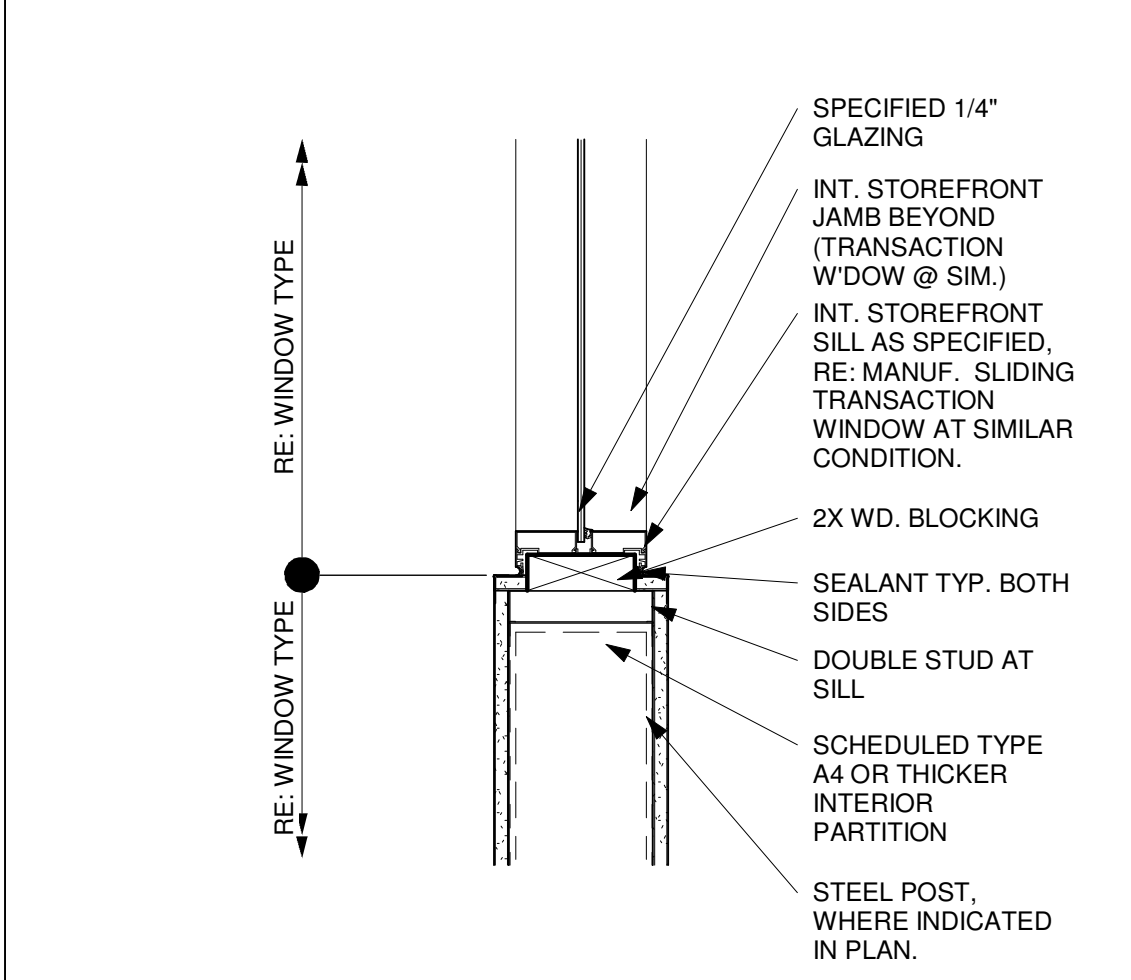
19 INT. STOREFRONT DOOR JAMB B
Scale: 1 1/2" = 1'-0"



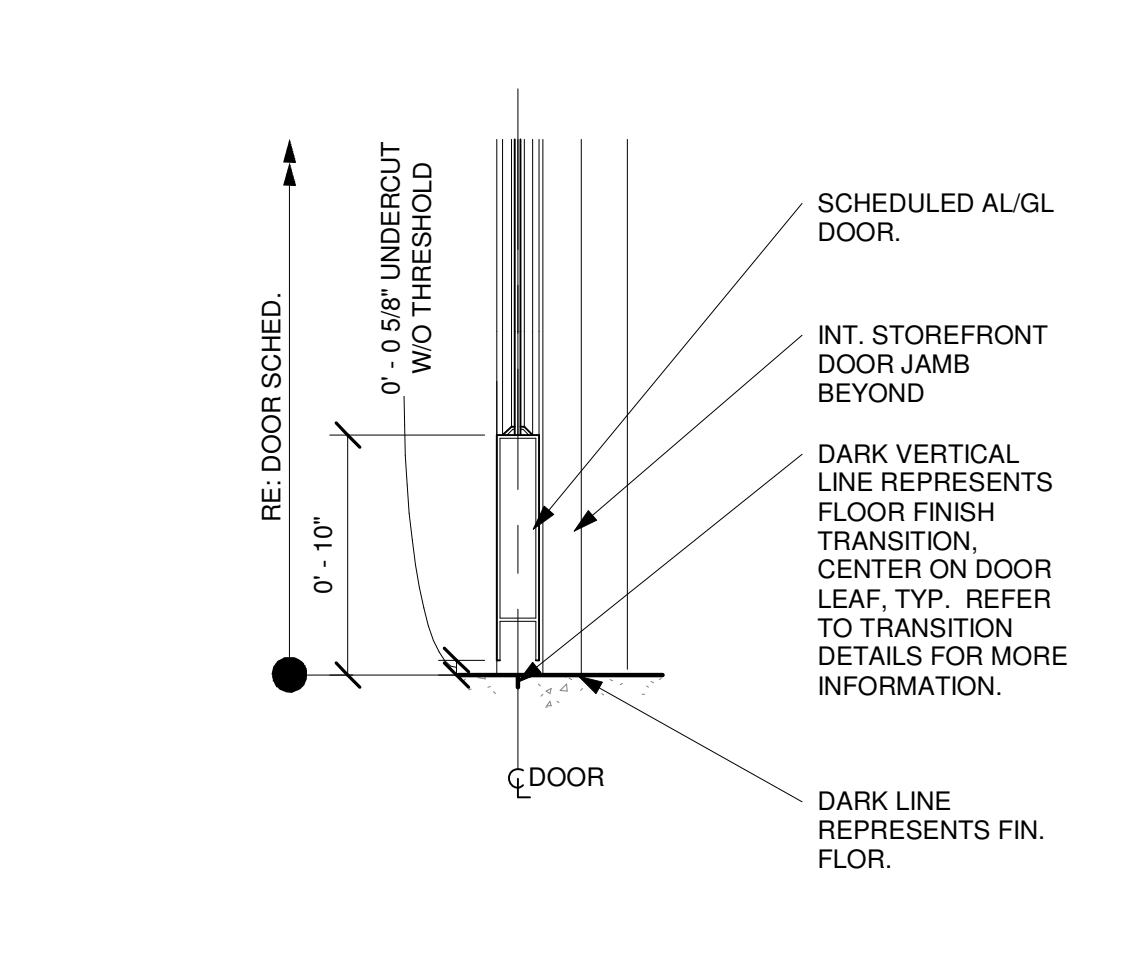
14 INTERIOR DOOR JAMB
Scale: 1 1/2" = 1'-0"



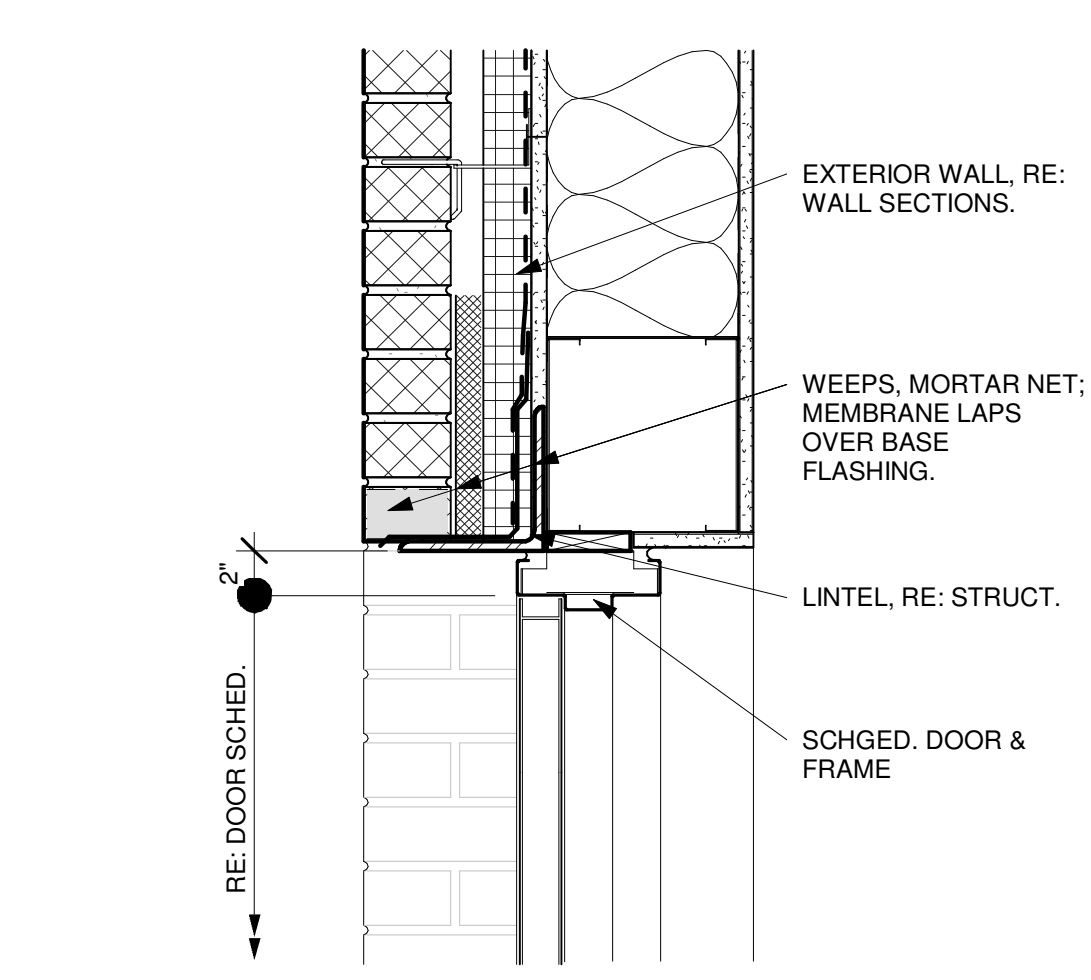
28 PRHT WINDOW HEAD
Scale: 1 1/2" = 1'-0"



23 INT. STOREFRONT SILL
Scale: 1 1/2" = 1'-0"

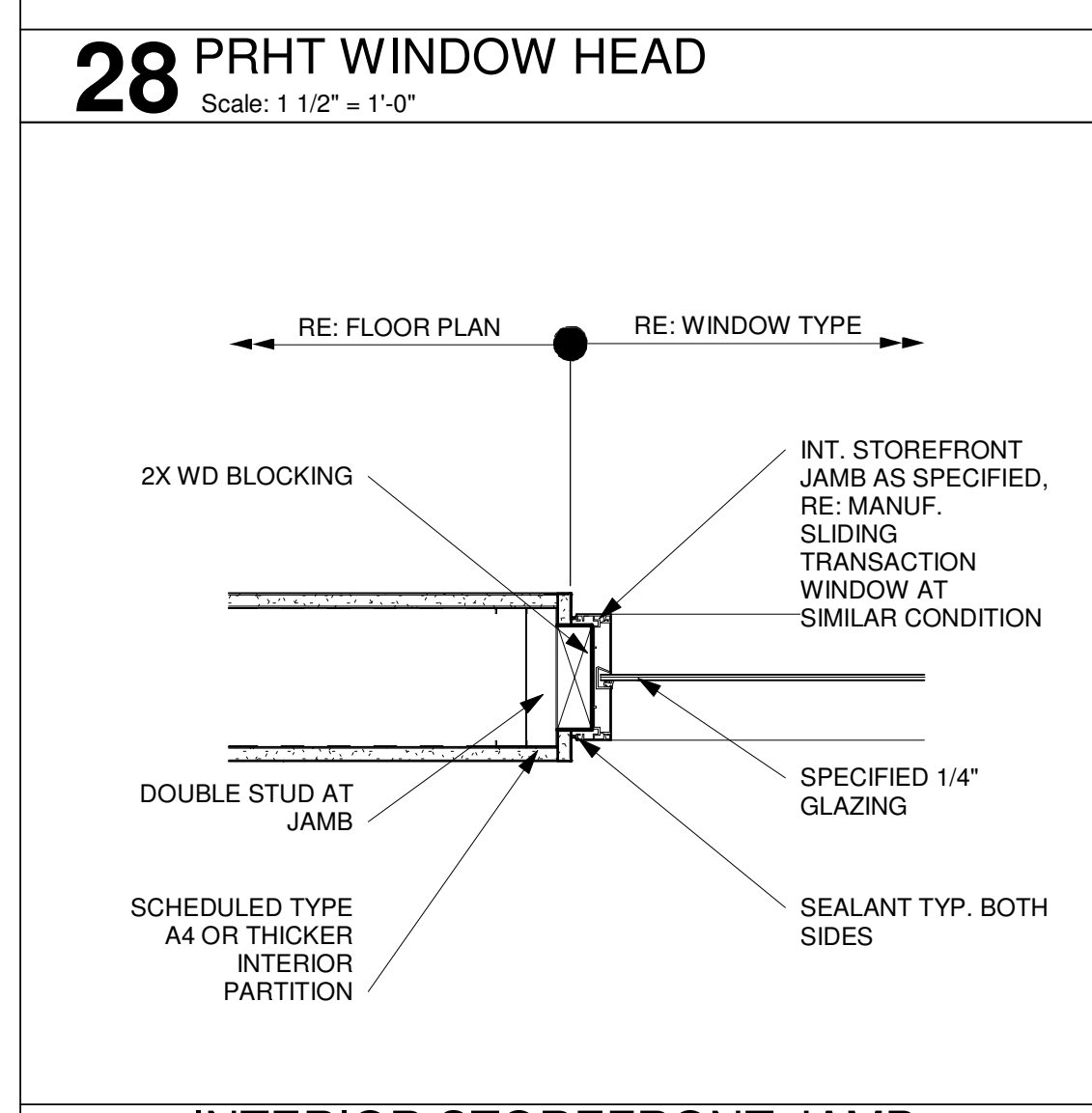


18 TYP. DOOR SILL
Scale: 1 1/2" = 1'-0"



13 EXT1A-8\"/>

Mark	Width x Height	Door Type	Door Material	Frame Type	Hardware Set	Firing Rating	Head Detail	Jamb Detail A	Jamb Detail B	Sill Detail	Card Reader	Comments
100A	6'-0" x 9'-5 5/8"	BB	AL/AL	ALE	714A	-	27/A5.01	06/A5.01	07/A5.01	26/A5.01	No	EXTERIOR DOOR
100B	6'-0" x 9'-5 5/8"	BB	AL/GL	ALE	C714A	-	27/A5.01	07/A5.01	06/A5.01	26/A5.01	Yes	EXTERIOR DOOR
101A	6'-0" x 8'-10 1/4"	BB	SCWD/GL	AL	710AC	-	25/A5.00	19/A5.00	-	18/A5.00	No	
101B	6'-0" x 8'-10 1/4"	BB	SCWD/GL	AL	C710AC	-	25/A5.00	19/A5.00	-	18/A5.00	Yes	
102A	3'-0" x 8'-10"	D	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
102B	3'-0" x 8'-10"	D	SCWD/GL	AL	800AC	-	20/A5.00	14/A5.00	-	18/A5.00	No	
103A	6'-0" x 8'-10"	AA	SCWD	HM	501C	-	15/A5.00	14/A5.00	-	18/A5.00	No	
103B	3'-0" x 8'-10"	A	SCWD	HM	800	-	15/A5.00	14/A5.00	-	26/A5.01	Yes	
104A	6'-0" x 8'-10"	AA	SCWD	HM	201	-	15/A5.00	14/A5.00	-	18/A5.00	No	
104B	3'-0" x 8'-10"	D	SCWD/GL	HM	501	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
104C	3'-0" x 8'-10"	D	SCWD/GL	AL	C201	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
105	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
107A	3'-0" x 8'-10"	A	SCWD	HM	401	-	15/A5.00	14/A5.00	-	18/A5.00	No	
107B	3'-0" x 8'-10"	A	SCWD	HM	401	-	15/A5.00	14/A5.00	-	18/A5.00	No	
107C	3'-0" x 8'-10"	A	SCWD	HM	403S	-	15/A5.00	14/A5.00	-	18/A5.00	No	
111	3'-0" x 8'-10"	D	SCWD/GL	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
108B	3'-0" x 8'-9 5/8"	B	AL/GL	ALE	C715A	-	22/A5.01	16/A5.01	06/A5.01	26/A5.01	Yes	EXTERIOR DOOR
109	3'-0" x 8'-10"	A	SCWD/GL	HM	203	-	15/A5.00	14/A5.00	-	18/A5.00	No	
110	3'-0" x 8'-10"	A	SCWD	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
112	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	17/A5.00	No	
113	3'-0" x 8'-10"	D	SCWD/GL	HM	501	-	15/A5.00	14/A5.00	-	18/A5.00	No	
114A	3'-0" x 8'-10"	C	SCWD	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
114B	3'-0" x 8'-10"	A	SCWD	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
115	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
116	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
117	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
118	3'-0" x 8'-9 5/8"	B	AL/GL	ALE	C715A	-	22/A5.01	16/A5.01	06/A5.01	26/A5.01	Yes	EXTERIOR DOOR
119	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
120	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
121	3'-0" x 8'-10"	D	SCWD/GL	HM	501	-	15/A5.00	14/A5.00	-	18/A5.00	No	
122	3'-0" x 8'-10 1/2"	B	SCWD/GL	AL	401	-	20/A5.00	19/A5.00	-	18/A5.00	No	
125A	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
125B	3'-0" x 8'-10"	A	SCWD	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
126	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
127	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
128	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
129	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
130	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
131	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
132	3'-0" x 8'-9 5/8"	B	AL/GL	ALE	C715A	-	22/A5.01	16/A5.01	06/A5.01	26/A5.01	Yes	EXTERIOR DOOR
134A	3'-0" x 8'-10"	A	SCWD	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
134B	3'-0" x 8'-10"	D	SCWD/GL	HM	201	-	15/A5.00	14/A5.00	-	18/A5.00	No	
135A	3'-0" x 8'-10"	A	SCWD	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	No	
135AA	3'-0" x 8'-2"	A	HM	HM	715	-	13/A5.00	12/A5.00	-	11/A5.00	No	EXTERIOR HM DOOR
135B	6'-0" x 9'-0"	AA	HM	HM	714	-	13/A5.00	12/A5.00	-	11/A5.00	No	EXTERIOR HM DOOR
136	3'-0" x 8'-10 1/2"	B	SCWD/GL	AL	401	-	20/A5.00	19/A5.00	24/A5.00	18/A5.00	Yes	
137	3'-0" x 8'-10"	A	SCWD	HM	801	-	15/A5.00	14/A5.00	-	17/A5.00	No	
138	3'-0" x 8'-10"	A	SCWD	HM	801	-	15/A5.00	14/A5.00	-	17/A5.00	No	
139	3'-0" x 8'-10 1/2"	B	SCWD/GL	AL	501	-	20/A5.00	19/A5.00	24/A5.00	18/A5.00	No	
140	3'-0" x 8'-10"	D	SCWD/GL	HM	501C	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
142	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
143	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
144	3'-0" x 8'-10"	D	SCWD/GL	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	No	
145	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
146	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
147	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
148	3'-0" x 8'-10"	D	SCWD/GL	HM	C701	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
149	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
150	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
150A	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
151	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
152	3'-0" x 8'-10"	D	SCWD/GL	HM	C701	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
153	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
154	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
155	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
156	3'-0" x 8'-10"	D	SCWD/GL	HM	501	-	15/A5.00	14/A5.00	-	18/A5.00	No	
157	3'-0" x 8'-10"	A	SCWD	HM	801	-	15/A5.00	14/A5.00	-	17/A5.00	No	
157A	3'-0" x 8'-10"	A	SCWD	HM	201	-	15/A5.00	14/A5.00	-	18/A5.00	No	
158	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
159	3'-0" x 8'-10"	A	SCWD	HM	203	-	15/A5.00	14/A5.00	-	18/A5.00	No	
160	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
161	3'-0" x 8'-10"	A	SCWD	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	No	
162	6'-0" x 8'-10"	AA	SCWD	HM	C200	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
163	3'-0" x 8'-9 5/8"	B	AL/GL	ALE	C715A	-	22/A5.01	16/A5.01	06/A5.01	26/A5.01	Yes	EXTERIOR DOOR
163A	3'-0" x 8'-10 1/2"	B	SCWD/GL	AL	401	-	20/A5.00	19/A5.00	24/A5.00	18/A5.00	Yes	
164	3'-0" x 8'-9 5/8"	B	AL/GL	ALE	C715A	-	22/A5.01	16/A5.01	06/A5.01	26/A5.01	Yes	EXTERIOR DOOR
165	3'-0" x 8'-10"	D	SCWD/GL	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
166	3'-0" x 8'-10"	D	SCWD/GL	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
168	3'-0" x 8'-10 1/2"	B	SCWD/GL	AL	501	-	20/A5.00	19/A5.00	24/A5.00	18/A5.00	No	
169	3'-0" x 8'-10"	A	SCWD	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
170	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	18/A5.00	No	
171	3'-0" x 8'-10"	D	SCWD/GL	HM	501	-	15/A5.00	14/A5.00	-	18/A5.00	No	
172	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
173	3'-0" x 8'-10"	D	SCWD	HM	C201	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
174	3'-0" x 8'-10"	D	SCWD/GL	HM	501C	-	15/A5.00	14/A5.00	-	18/A5.00	Yes	
175	3'-0" x 8'-10 1/2"	B	SCWD/GL	AL	401	-	20/A5.00	19/A5.00	24/A5.00	18/A5.00	No	
177	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
178	3'-0" x 8'-10"	A	SCWD	HM	203	-	15/A5.00	14/A5.00	-	18/A5.00	No	
179	3'-0" x 8'-10"	D	SCWD/GL	HM	501	-	15/A5.00	14/A5.00	-	18/A5.00	No	
180	3'-0" x 8'-10"	C	SCWD/GL	HM	103	-	15/A5.00	14/A5.00	-	18/A5.00	No	
181	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
182	3'-0" x 8'-10"	A	SCWD	HM	341	-	15/A5.00	14/A5.00	-	17/A5.00	No	
183	3'-0" x 8'-10"	A	HM	HM	205	-	13/A5.00	12/A5.00	-	11/A5.00	No	EXTERIOR HM DOOR
184	3'-0" x 8'-10"	A	SCWD	HM	C201	-	15/A5.00	14/A5.00	-	17/A5.00	No	



27 INTERIOR STOREFRONT JAMB
Scale: 1 1/2" = 1'-0"

ELECTRICAL SPECIFICATIONS

(BOOKS SPECIFICATIONS SUPERCEDE ANY NOTES BELOW)

1. SCOPE: THIS DIVISION SHALL INCLUDE ALL EQUIPMENT, MATERIALS, AND LABOR REQUIRED FOR COMPLETE INSTALLATION OF THE ELECTRICAL SYSTEM. PROJECT INCLUDES INSTALLATION OF NEW ELECTRICAL DISTRIBUTION SYSTEM, HVAC SYSTEM CONNECTIONS, NEW LIGHTING SYSTEM, NEW RECEPTACLES AND OUTLETS, FIRE ALARM AND NOTIFICATION SYSTEM, AND OTHER ELECTRICAL WORK AS INDICATED ON THE PLANS. CONTRACTOR SHALL PROVIDE CONDUITS, CONDUCTORS FOR POWER, LIGHTING, AND LIGHTING CONTACTOR AND CONTACT CLOSURES, AND ALL REQUIRED APPARATUS REQUIRED FOR FULL OPERATION OF THE ELECTRICAL SYSTEM. SITE VISIT AND FAMILIARIZATION: CONTRACTORS PROPOSING TO UNDERTAKE WORK UNDER THIS DIVISION SHALL VISIT THE SITE OF THE WORK AND FULLY INFORM THEMSELVES OF ALL CONDITIONS THAT AFFECT THE WORK, OR COST THEREOF. CONTRACTOR SHALL EXAMINE THE DRAWINGS AND SPECIFICATIONS AS RELATED TO THE SITE CONDITIONS. ANY DISCREPANCIES SHALL BE REPORTED TO THE ENGINEER. NOTICE: CONSIDERATION WILL NOT BE GRANTED FOR ANY ALLEGED MISUNDERSTANDING OF THE AMOUNT OF WORK TO BE PERFORMED. TENDER OF A PROPOSAL SHALL CONVEY FULL AGREEMENT TO ALL ITEMS AND CONDITIONS SPECIFIED, INDICATED ON THE DRAWINGS, AND/OR REQUIRED BY NATURE OF THE SITE. DISCREPANCIES SHOULD CONTRACTOR FIND DISCREPANCIES OR OMISSIONS IN THE CONTRACT DOCUMENTS, OR BE IN DOUBT AS TO THE INTENT THEREOF, HE SHALL IMMEDIATELY OBTAIN CLARIFICATION FROM THE ARCHITECT BEFORE SUBMITTING PROPOSAL FOR WORK IN THIS DIVISION.	20. SWITCHES: FURNISH AND INSTALL ALL FUSIBLE AND NON-FUSIBLE SWITCHES AS REQUIRED BY CODES, WHETHER OR NOT SHOWN AND/OR NOTED. SWITCHES SHALL BE: A. HEAVY DUTY WITH NEMA-1 OR 3R ENCLOSURE, AS REQUIRED, AND BE PROVIDED WITH RATED BREAKING CAPACITY. B. PROVIDED AT EACH MOTOR THAT IS OUT OF SIGHT OF THE SWITCH OR PANEL FROM WHICH FED, AND BE NON-FUSIBLE DISCONNECT FOR SUCH USE. C. SWITCH MANUFACTURER SHALL BE GE, WESTINGHOUSE, OR SQUARE D. D. DISCONNECT SWITCHES INSTALLED OUTSIDE THE BUILDING SHALL BE IN NEMA-3 ENCLOSURES. E. FUSIBLE SWITCH-STARTER UNITS: EACH UNIT SHALL BE TOTALLY ENCLOSED AND EFFECTIVELY BARRIRED, MANUALLY OPERATED QUICK-MAKE, QUICK BREAK, HORSEPOWER RATED STARTER. PROVIDE CLASS R TYPE REJECTION FUSE CLIPS. IDENTIFY EACH DEVICE WITH NAMEPLATE SHOWING THE LOAD SERVED, MACHINING THE EXISTING NAMEPLATE. F. WIRING DEVICES: FURNISH AND INSTALL ALL WIRING DEVICES AS INDICATED ON THE DRAWINGS. DEVICES SHALL, IN ALL CASES BE SUITABLE FOR THE USE INTENDED AND SHALL HAVE VOLTAGE AND CURRENT RATINGS ADEQUATE FOR THE LOADS TO BE SERVED. A. MOUNTING: HEIGHTS OF ALL DEVICES ARE FROM FINISH FLOOR TO CENTERLINE OF DEVICE. DEVICES SHOWN ON THE DRAWINGS IN GROUPS OF TWO OR MORE SHALL BE LOCATED HORIZONTALLY IN SUCH A MANNER AS TO BE CLOSE AS POSSIBLE FROM THE CENTERLINE OF THE FIRST DEVICE TO THE CENTERLINE OF THE NEXT DEVICE UNLESS OTHERWISE NOTED. B. WALL SWITCHES: SHALL BE LEVITON DECORA TYPE, WHITE IN COLOR. USE CORRESPONDING DOUBLE POLE, THREE-WAY, FOUR-WAY, KEVED AND DIMMER SWITCHES WHERE NOTED. MOUNT AT 3'-10" A.F.F. AND WITHIN 6" OF ADJACENT DOOR JAMB, UNLESS OTHERWISE NOTED. USE "KEYED" SWITCHES IN LOCATIONS INDICATED. CONVENIENCE OUTLETS: SHALL BE GROUNDED TYPE, 20 AMP, 125 VOLT, LEVITON, WHITE COLOR. WEATHERPROOF DUPLEX OUTLETS SHALL BE LEVITON 5342 WITH SIERRA NO. WITH 4-PLATE. MOUNT AT 3'-10" A.F.F. UNLESS OTHERWISE NOTED. PROVIDE NEMA 5-20R GFCI PROTECTED RECEPTACLE WITH INTEGRAL TEST AND RESET SWITCH SPECIFICATION (SPEC) GRADE HEAVY DUTY STRAIGHT BLADE DEVICES UNLESS OTHERWISE NOTED. PROVIDE HOSPITAL GRADE DEVICES WHERE INDICATED, OR AS REQUIRED BY CODES. D. ACCEPTABLE ALTERNATE MANUFACTURERS: SHALL BE LSI, H.E. WILLIAMS, HUBBELL, PAS AND BRYANT, PROVIDED THEIR DEVICES BE OF THE SAME TYPE AND QUALITY AND THAT ONLY ONE MANUFACTURER SHALL BE USED THROUGHOUT THE WORK. PLATES: SHALL BE MATCHING TYPE FOR FINISHED AREAS AND GALVANIZED STEEL FOR AREAS WITH PROVISIONS FOR PLUMBING. PROVIDE CAST ALUMINUM WET LOCATION TYPE COVER PLATES WITH HINGED COVERS FOR DEVICES LOCATED OUTSIDE. GANG OUTLETS GROUPED TOGETHER UNDER A SINGLE WALL PLATE. F. INCANDESCENT DIMMERS: 120V SLIDE TO OFF, DECORA STYLE SIMILAR TO SWITCHES, WITH WATTAGE AS REQUIRED PER MANUFACTURER'S RECOMMENDATIONS. POWER FAILURE MEMORY: RFI SUPPRESSION, WHERE SWITCHES ARE SHOWN TO USE DIMMERS, PROVIDE MULTI-GANG COVER PLATES. PROVIDE DIMMERS WITH IVORY FINISH, SAME AS SWITCHES UNLESS OTHERWISE DIRECTED. G. PROVIDE MANUFACTURER'S WRITTEN INSTRUCTIONS, APPLICABLE REQUIREMENTS OF NEC AND IN ACCORDANCE WITH RECOGNIZED INDUSTRY PRACTICES TO FULFILL PROJECT REQUIREMENTS. H. TIGHTEN CONNECTIONS AND TERMINALS, INCLUDING SCREWS AND BOLTS, IN ACCORDANCE WITH EQUIPMENT MANUFACTURER'S PUBLISHED TORQUE VALUES FOR WIRING DEVICES. I. COORDINATE WITH OTHER WORK, INCLUDING PAINTING, ELECTRICAL BOXES AND WIRING INSTALLATIONS, AS NECESSARY TO INTERFACE INSTALLATION OF WIRING DEVICES WITH OTHER WORK. J. INSTALL WIRING DEVICES AFTER WIRING WORK IS COMPLETED, INSTALL ONLY IN ELECTRICAL BOXES THAT ARE CLEAN, FREE FROM EXCESS BUILDING MATERIALS, DIRT, AND DEBRIS. INSTALL WALL PLATES AFTER PAINTING WORK IS COMPLETED. K. NO RECEPTACLE SWITCH OUTLETS SHALL BE ROUTED BACK TO BACK. A MINIMUM OF ONE (1) STUD MUST BE BETWEEN OUTLETS. L. INSTALL RECEPTACLES WITH GROUND PIN UP. INSTALL SWITCHES WITH THE "ON" POSITION UP. M. ALL EXTERIOR DEVICES TO BE WEATHER PROOF AND EXTERIOR RECEPTACLES SHALL BE A GFCI TYPE DEVICE. N. INSTALL WIRING DEVICES OUTLETS LOCATED WITHIN SIX FEET OF SINKS SHALL HAVE GROUND FAULT CIRCUIT INTERRUPTION PROTECTION. GROUND FAULT OUTLETS SHALL BE CONNECTED ON DEDICATED NEUTRAL, WIRE SERVING ONLY THE INDIVIDUAL OUTLET WITH THE GROUND FAULT PROTECTION. O. USE JUMBO SIZE WALL PLATES FOR OUTLETS INSTALLED IN MASONRY WALLS. P. DO NOT SHARE NEUTRAL CONDUCTORS ON DIMMERS.
2. DEMOLITION: ALL ELECTRICAL COMPONENTS OF THE EXISTING SYSTEM WHICH ARE NOT UTILIZED FOR NEW CONFIGURATION SHALL BE REMOVED AND DISPOSED OF BY CONTRACTOR. REFER TO DEMOLITION NOTES AND DRAWINGS FOR EXTENT OF WORK. TIMELY PLACING OF MATERIALS AND EQUIPMENT: ALL ELECTRICAL APPARATUS SHALL BE INSTALLED AT THE PROPER TIME DURING PROGRESS OF MASONRY CONSTRUCTION. COORDINATE WORK OPERATIONS WITH OTHER CRAFTS.	21. WIRING DEVICES: FURNISH AND INSTALL ALL WIRING DEVICES AS INDICATED ON THE DRAWINGS. DEVICES SHALL, IN ALL CASES BE SUITABLE FOR THE USE INTENDED AND SHALL HAVE VOLTAGE AND CURRENT RATINGS ADEQUATE FOR THE LOADS TO BE SERVED. A. MOUNTING: HEIGHTS OF ALL DEVICES ARE FROM FINISH FLOOR TO CENTERLINE OF DEVICE. DEVICES SHOWN ON THE DRAWINGS IN GROUPS OF TWO OR MORE SHALL BE LOCATED HORIZONTALLY IN SUCH A MANNER AS TO BE CLOSE AS POSSIBLE FROM THE CENTERLINE OF THE FIRST DEVICE TO THE CENTERLINE OF THE NEXT DEVICE UNLESS OTHERWISE NOTED. B. WALL SWITCHES: SHALL BE LEVITON DECORA TYPE, WHITE IN COLOR. USE CORRESPONDING DOUBLE POLE, THREE-WAY, FOUR-WAY, KEVED AND DIMMER SWITCHES WHERE NOTED. MOUNT AT 3'-10" A.F.F. AND WITHIN 6" OF ADJACENT DOOR JAMB, UNLESS OTHERWISE NOTED. USE "KEYED" SWITCHES IN LOCATIONS INDICATED. CONVENIENCE OUTLETS: SHALL BE GROUNDED TYPE, 20 AMP, 125 VOLT, LEVITON, WHITE COLOR. WEATHERPROOF DUPLEX OUTLETS SHALL BE LEVITON 5342 WITH SIERRA NO. WITH 4-PLATE. MOUNT AT 3'-10" A.F.F. UNLESS OTHERWISE NOTED. PROVIDE NEMA 5-20R GFCI PROTECTED RECEPTACLE WITH INTEGRAL TEST AND RESET SWITCH SPECIFICATION (SPEC) GRADE HEAVY DUTY STRAIGHT BLADE DEVICES UNLESS OTHERWISE NOTED. PROVIDE HOSPITAL GRADE DEVICES WHERE INDICATED, OR AS REQUIRED BY CODES. D. ACCEPTABLE ALTERNATE MANUFACTURERS: SHALL BE LSI, H.E. WILLIAMS, HUBBELL, PAS AND BRYANT, PROVIDED THEIR DEVICES BE OF THE SAME TYPE AND QUALITY AND THAT ONLY ONE MANUFACTURER SHALL BE USED THROUGHOUT THE WORK. PLATES: SHALL BE MATCHING TYPE FOR FINISHED AREAS AND GALVANIZED STEEL FOR AREAS WITH PROVISIONS FOR PLUMBING. PROVIDE CAST ALUMINUM WET LOCATION TYPE COVER PLATES WITH HINGED COVERS FOR DEVICES LOCATED OUTSIDE. GANG OUTLETS GROUPED TOGETHER UNDER A SINGLE WALL PLATE. F. INCANDESCENT DIMMERS: 120V SLIDE TO OFF, DECORA STYLE SIMILAR TO SWITCHES, WITH WATTAGE AS REQUIRED PER MANUFACTURER'S RECOMMENDATIONS. POWER FAILURE MEMORY: RFI SUPPRESSION, WHERE SWITCHES ARE SHOWN TO USE DIMMERS, PROVIDE MULTI-GANG COVER PLATES. PROVIDE DIMMERS WITH IVORY FINISH, SAME AS SWITCHES UNLESS OTHERWISE DIRECTED. G. PROVIDE MANUFACTURER'S WRITTEN INSTRUCTIONS, APPLICABLE REQUIREMENTS OF NEC AND IN ACCORDANCE WITH RECOGNIZED INDUSTRY PRACTICES TO FULFILL PROJECT REQUIREMENTS. H. TIGHTEN CONNECTIONS AND TERMINALS, INCLUDING SCREWS AND BOLTS, IN ACCORDANCE WITH EQUIPMENT MANUFACTURER'S PUBLISHED TORQUE VALUES FOR WIRING DEVICES. I. COORDINATE WITH OTHER WORK, INCLUDING PAINTING, ELECTRICAL BOXES AND WIRING INSTALLATIONS, AS NECESSARY TO INTERFACE INSTALLATION OF WIRING DEVICES WITH OTHER WORK. J. INSTALL WIRING DEVICES AFTER WIRING WORK IS COMPLETED, INSTALL ONLY IN ELECTRICAL BOXES THAT ARE CLEAN, FREE FROM EXCESS BUILDING MATERIALS, DIRT, AND DEBRIS. INSTALL WALL PLATES AFTER PAINTING WORK IS COMPLETED. K. NO RECEPTACLE SWITCH OUTLETS SHALL BE ROUTED BACK TO BACK. A MINIMUM OF ONE (1) STUD MUST BE BETWEEN OUTLETS. L. INSTALL RECEPTACLES WITH GROUND PIN UP. INSTALL SWITCHES WITH THE "ON" POSITION UP. M. ALL EXTERIOR DEVICES TO BE WEATHER PROOF AND EXTERIOR RECEPTACLES SHALL BE A GFCI TYPE DEVICE. N. INSTALL WIRING DEVICES OUTLETS LOCATED WITHIN SIX FEET OF SINKS SHALL HAVE GROUND FAULT CIRCUIT INTERRUPTION PROTECTION. GROUND FAULT OUTLETS SHALL BE CONNECTED ON DEDICATED NEUTRAL, WIRE SERVING ONLY THE INDIVIDUAL OUTLET WITH THE GROUND FAULT PROTECTION. O. USE JUMBO SIZE WALL PLATES FOR OUTLETS INSTALLED IN MASONRY WALLS. P. DO NOT SHARE NEUTRAL CONDUCTORS ON DIMMERS.
3. DEMOLITION: ALL ELECTRICAL COMPONENTS OF THE EXISTING SYSTEM WHICH ARE NOT UTILIZED FOR NEW CONFIGURATION SHALL BE REMOVED AND DISPOSED OF BY CONTRACTOR. REFER TO DEMOLITION NOTES AND DRAWINGS FOR EXTENT OF WORK. TIMELY PLACING OF MATERIALS AND EQUIPMENT: ALL ELECTRICAL APPARATUS SHALL BE INSTALLED AT THE PROPER TIME DURING PROGRESS OF MASONRY CONSTRUCTION. COORDINATE WORK OPERATIONS WITH OTHER CRAFTS.	22. PROTECTION OF APPARATUS: TAKE ALL PRECAUTIONS NECESSARY FOR PROPER PROTECTION OF NEW EQUIPMENT, APPARATUS, AND MATERIALS FROM DAMAGE. FAILURE TO DO SO WILL BE CAUSE FOR REJECTION OF ANY ITEM CONCERNING THIS QUESTION.
4. SHOP DRAWINGS: CONTRACTOR FOR THIS DIVISION SHALL SUBMIT SHOP DRAWINGS AND CALCULATION DATA ON ALL MAJOR ITEMS OF EQUIPMENT AND SYSTEMS AND OTHER MATERIAL REQUESTED BY ARCHITECT/ENGINEER. SUBMIT PRODUCT DATA FOR SWITCHBOARDS, PANELBOARDS, TRANSFORMERS, WIRES, CABLE, SUPPORTING DEVICES, IDENTIFICATION COMPONENTS, LIGHT FIXTURES, FIRE ALARM SYSTEM AND COMPONENTS, WIRING DEVICES, MULTI-OUTLET RACEWAYS, CABINETS, AND BOXES. SUBMIT SIX COPIES WITHIN THIRTY (30) DAYS AFTER CONTRACT AWARD, AND IN NOT MORE THAN TWO GROUPS OF SUBMITTALS. SUBMITTALS SHALL CONSIST OF LAYOUTS, WIRING DRAWINGS, CUTS, AND OPERATING AND PERFORMANCE DATA. ALLOW FOUR (4) WEEKS FOR REVIEW AND APPROVAL OF THE SHOP DRAWINGS BY ENGINEER.	23. SHOP DRAWINGS: CONTRACTOR FOR THIS DIVISION SHALL SUBMIT SHOP DRAWINGS AND CALCULATION DATA ON ALL MAJOR ITEMS OF EQUIPMENT AND SYSTEMS AND OTHER MATERIAL REQUESTED BY ARCHITECT/ENGINEER. SUBMIT PRODUCT DATA FOR SWITCHBOARDS, PANELBOARDS, TRANSFORMERS, WIRES, CABLE, SUPPORTING DEVICES, IDENTIFICATION COMPONENTS, LIGHT FIXTURES, FIRE ALARM SYSTEM AND COMPONENTS, WIRING DEVICES, MULTI-OUTLET RACEWAYS, CABINETS, AND BOXES. SUBMIT SIX COPIES WITHIN THIRTY (30) DAYS AFTER CONTRACT AWARD, AND IN NOT MORE THAN TWO GROUPS OF SUBMITTALS. SUBMITTALS SHALL CONSIST OF LAYOUTS, WIRING DRAWINGS, CUTS, AND OPERATING AND PERFORMANCE DATA. ALLOW FOUR (4) WEEKS FOR REVIEW AND APPROVAL OF THE SHOP DRAWINGS BY ENGINEER.
5. MATERIALS AND WORKMANSHIP: ALL MATERIALS AND EQUIPMENT SHALL BE NEW OF BEST GRADE OF STANDARD MANUFACTURE. APPROVED BY UL, AND BE SO LABELED. FOR WIRE AND CABLE, MARKED AS REQUIRED BY ART. 310-2, NEC. INSTALLED BY SKILLED ELECTRICIAN WORKING UNDER THE DIRECT SUPERVISION OF COMPETENT EXPERIENCED FOREMAN AND/OR SUPERINTENDENT. PRODUCTS SHALL BE INSTALLED IN A THOROUGH WORKMANLIKE MANNER, PRESENTING A NEAT, CLEAN-CUT APPEARANCE WHEN COMPLETED. ANY PART OR PARTS NOT MEETING THIS REQUIREMENT SHALL BE REPLACED OR REBUILT WITHOUT EXTRA EXPENSE TO OWNER.	24. MATERIALS AND WORKMANSHIP: ALL MATERIALS AND EQUIPMENT SHALL BE NEW OF BEST GRADE OF STANDARD MANUFACTURE. APPROVED BY UL, AND BE SO LABELED. FOR WIRE AND CABLE, MARKED AS REQUIRED BY ART. 310-2, NEC. INSTALLED BY SKILLED ELECTRICIAN WORKING UNDER THE DIRECT SUPERVISION OF COMPETENT EXPERIENCED FOREMAN AND/OR SUPERINTENDENT. PRODUCTS SHALL BE INSTALLED IN A THOROUGH WORKMANLIKE MANNER, PRESENTING A NEAT, CLEAN-CUT APPEARANCE WHEN COMPLETED. ANY PART OR PARTS NOT MEETING THIS REQUIREMENT SHALL BE REPLACED OR REBUILT WITHOUT EXTRA EXPENSE TO OWNER.
6. PROTECTION OF EXISTING: PLENUM CABLE SHALL BE PROPERLY SECURED ABOVE CEILING PER FIRE RATED CABLE CODES.	25. PROTECTION OF EXISTING: PLENUM CABLE SHALL BE PROPERLY SECURED ABOVE CEILING PER FIRE RATED CABLE CODES.
7. WIRING METHODS: THE DRAWINGS ARE DIAGRAMMATIC AND ARE INTENDED TO SHOW THE LOCATIONS OF EQUIPMENT AND ARRANGEMENT OF CIRCUITS ONLY. EXACT LOCATIONS SHALL BE DETERMINED BY ACTUAL MEASUREMENT AT THE SITE. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ALL RISERS, DROPS, OFFSETS, ETC. NECESSARY TO AVOID CONFLICT WITH STRUCTURAL MEMBERS, AND SIMILAR ITEMS, WHEN INSTALLING ELECTRICAL CONDUITS. INSTALL EXPOSED CONDUIT AS SHOWN OR NOTED, PARALLEL TO HORIZONTAL AND VERTICAL LINES OF STRUCTURES. MAKE BENDS WITH 90 DEGREE TURN ONLY, OR WITH APPROVED FITTINGS.	26. WIRING METHODS: THE DRAWINGS ARE DIAGRAMMATIC AND ARE INTENDED TO SHOW THE LOCATIONS OF EQUIPMENT AND ARRANGEMENT OF CIRCUITS ONLY. EXACT LOCATIONS SHALL BE DETERMINED BY ACTUAL MEASUREMENT AT THE SITE. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ALL RISERS, DROPS, OFFSETS, ETC. NECESSARY TO AVOID CONFLICT WITH STRUCTURAL MEMBERS, AND SIMILAR ITEMS, WHEN INSTALLING ELECTRICAL CONDUITS. INSTALL EXPOSED CONDUIT AS SHOWN OR NOTED, PARALLEL TO HORIZONTAL AND VERTICAL LINES OF STRUCTURES. MAKE BENDS WITH 90 DEGREE TURN ONLY, OR WITH APPROVED FITTINGS.
8. CONDUIT: FURNISH A COMPLETE RACEWAY SYSTEM FOR BUT NOT LIMITED TO FEEDER, BRANCH CIRCUITS, CONTROL WIRING, AND AUXILIARY SYSTEM WIRING.	27. CONDUIT: FURNISH A COMPLETE RACEWAY SYSTEM FOR BUT NOT LIMITED TO FEEDER, BRANCH CIRCUITS, CONTROL WIRING, AND AUXILIARY SYSTEM WIRING.
9. A. USE LIQUID TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS FOR ALL MOTORIZED CONNECTIONS, WHERE EQUIPMENT IS SUBJECT TO MOVEMENT, OR LOCATED OUTDOOR. B. WHERE ENTERING PANELS, PULL BOXES, J-BOXES, OR OUTLET BOXES, SECURED IN PLACE WITH WIRE LOCK-NUTS INSIDE AND OUTSIDE, AND INSULATED BUSHING INSIDE. C. BENDS AND OFFSETS MADE WITH APPROVED TOOLS ONLY. BENDS OR OFFSETS IN WHICH THE PIPE IS CRUSHED OR DEFORMED SHALL NOT BE INSTALLED. D. USE EMT FOR INTERIOR DRY LOCATIONS, PVC FOR UNDERGROUND INSTALLATION, AND RIGID GALVANIZED STEEL FOR EXPOSED LOCATIONS SUBJECT TO DAMAGE.	28. A. USE LIQUID TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS FOR ALL MOTORIZED CONNECTIONS, WHERE EQUIPMENT IS SUBJECT TO MOVEMENT, OR LOCATED OUTDOOR. B. WHERE ENTERING PANELS, PULL BOXES, J-BOXES, OR OUTLET BOXES, SECURED IN PLACE WITH WIRE LOCK-NUTS INSIDE AND OUTSIDE, AND INSULATED BUSHING INSIDE. C. BENDS AND OFFSETS MADE WITH APPROVED TOOLS ONLY. BENDS OR OFFSETS IN WHICH THE PIPE IS CRUSHED OR DEFORMED SHALL NOT BE INSTALLED. D. USE EMT FOR INTERIOR DRY LOCATIONS, PVC FOR UNDERGROUND INSTALLATION, AND RIGID GALVANIZED STEEL FOR EXPOSED LOCATIONS SUBJECT TO DAMAGE.
10. OUTLET AND JUNCTION BOXES: FURNISH AND INSTALL ALL JUNCTION BOXES ROUTED TO FACILITATE INSTALLATION OF THE VARIOUS CONDUIT SYSTEMS. JUNCTION BOXES SHALL BE SUITABLE FOR ENVIRONMENT AND APPLICATION USED FOR WIRE AND CABLE. ALL WIRE AND CABLE SHALL: A. BE NEW AND OF SOFT DRAWN, ANNEALED, COPPER HAVING A CONDUCTIVITY OF NOT LESS THAN 98% OF THAT OF PURE COPPER. EACH WIRE CONTINUOUS WITHOUT WELD, SPLICE OR JOINT THROUGHOUT ITS LENGTH. UNIFORM IN CROSS SECTION AND FREE FROM FLAWS, SCALES, AND OTHER IMPERFECTIONS. B. UNLESS OTHERWISE SPECIFIED OR NOTED, WIRES SHALL BE #12 AWG (FOR PHASE, NEUTRAL, AND GROUND CONDUCTORS) TYPE THW, THWN, THHN, AS MANUFACTURED BY TRIANGLE, GENERAL ELECTRIC, OKONITE, OR ANACONDA. C. ALL WIRE #8 AND LARGER SHALL BE STRANDED. D. NOT BE DRAWN INTO A CONDUIT UNTIL ALL WORK WHICH MAY CAUSE INJURY TO INSULATION IS COMPLETE. WHERE TWO OR MORE CIRCUITS RUN TO A SINGLE OUTLET BOX, TAG EACH CIRCUIT AS A GUIDE. E. HAVE ALL STRANDED CONDUCTORS FURNISHED WITH COPPER CONNECTING LUGS, DRILLED, OR REAMED THE FULL DIAMETER OF THE BARE CONDUCTORS. MAINS AND FEEDERS SHALL BE RUN THEIR ENTIRE LENGTH IN CONTINUOUS PIECES WITHOUT JOINTS OR SPLICES.	29. OUTLET AND JUNCTION BOXES: FURNISH AND INSTALL ALL JUNCTION BOXES ROUTED TO FACILITATE INSTALLATION OF THE VARIOUS CONDUIT SYSTEMS. JUNCTION BOXES SHALL BE SUITABLE FOR ENVIRONMENT AND APPLICATION USED FOR WIRE AND CABLE. ALL WIRE AND CABLE SHALL: A. BE NEW AND OF SOFT DRAWN, ANNEALED, COPPER HAVING A CONDUCTIVITY OF NOT LESS THAN 98% OF THAT OF PURE COPPER. EACH WIRE CONTINUOUS WITHOUT WELD, SPLICE OR JOINT THROUGHOUT ITS LENGTH. UNIFORM IN CROSS SECTION AND FREE FROM FLAWS, SCALES, AND OTHER IMPERFECTIONS. B. UNLESS OTHERWISE SPECIFIED OR NOTED, WIRES SHALL BE #12 AWG (FOR PHASE, NEUTRAL, AND GROUND CONDUCTORS) TYPE THW, THWN, THHN, AS MANUFACTURED BY TRIANGLE, GENERAL ELECTRIC, OKONITE, OR ANACONDA. C. ALL WIRE #8 AND LARGER SHALL BE STRANDED. D. NOT BE DRAWN INTO A CONDUIT UNTIL ALL WORK WHICH MAY CAUSE INJURY TO INSULATION IS COMPLETE. WHERE TWO OR MORE CIRCUITS RUN TO A SINGLE OUTLET BOX, TAG EACH CIRCUIT AS A GUIDE. E. HAVE ALL STRANDED CONDUCTORS FURNISHED WITH COPPER CONNECTING LUGS, DRILLED, OR REAMED THE FULL DIAMETER OF THE BARE CONDUCTORS. MAINS AND FEEDERS SHALL BE RUN THEIR ENTIRE LENGTH IN CONTINUOUS PIECES WITHOUT JOINTS OR SPLICES.
11. IDENTIFICATION OF CONDUCTORS AND PANELBOARD ELEMENTS: A. EACH AND EVERY MAIN AND FEEDER CONDUCTOR SHALL BE IDENTIFIED AT EACH OUTLET POINT WHERE SUCH CONDUCTOR TERMINATES. FEEDER BUNDLES PASSING THROUGH A JUNCTION OR SUPPORT BOX SHALL ALSO BE IDENTIFIED WITHIN SUCH ENCLOSURE, BUT MAY BE IDENTIFIED IN SUCH LOCATIONS AS A GROUP. B. IDENTIFY BY USE OF PERMANENT TYPE BANDS, BRADY, OR T AND B A DEFINITE NUMBER AND/OR LETTER CODE SHALL BE EMPLOYED AND BE UNIFORM THROUGHOUT EACH CONDUCTOR. C. IDENTIFY EACH SWITCH, INCLUDING MAIN DISCONNECT AND MOTOR STARTER WITH WHITE-ON-BLACK NAMEPLATE, EACH WITH HIGH LETTERS, NEATLY AND SECURELY ADHERE NAMEPLATES TO THE UNIT.	30. IDENTIFICATION OF CONDUCTORS AND PANELBOARD ELEMENTS: A. EACH AND EVERY MAIN AND FEEDER CONDUCTOR SHALL BE IDENTIFIED AT EACH OUTLET POINT WHERE SUCH CONDUCTOR TERMINATES. FEEDER BUNDLES PASSING THROUGH A JUNCTION OR SUPPORT BOX SHALL ALSO BE IDENTIFIED WITHIN SUCH ENCLOSURE, BUT MAY BE IDENTIFIED IN SUCH LOCATIONS AS A GROUP. B. IDENTIFY BY USE OF PERMANENT TYPE BANDS, BRADY, OR T AND B A DEFINITE NUMBER AND/OR LETTER CODE SHALL BE EMPLOYED AND BE UNIFORM THROUGHOUT EACH CONDUCTOR. C. IDENTIFY EACH SWITCH, INCLUDING MAIN DISCONNECT AND MOTOR STARTER WITH WHITE-ON-BLACK NAMEPLATE, EACH WITH HIGH LETTERS, NEATLY AND SECURELY ADHERE NAMEPLATES TO THE UNIT.
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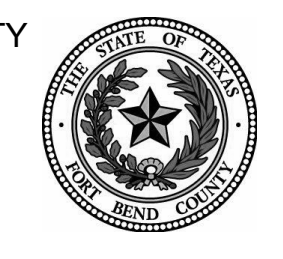
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	ABBREVIATION DEFINITIONS
	HOME RUN TO INDICATED PANEL AND CIRCUIT NUMBER REFER TO PANEL SCHEDULE FOR BRANCH CIRCUIT INFORMATION, INCLUDING BREAKER RATINGS, WIRE SIZE/QUANTITY, AND CONDUIT SIZE/TYP		LIGHTING CLASS PANEL HA = PANEL NAME CHARACTERISTICS AS INDICATED ON ONE LINE DIAGRAM AND PANEL SCHEDULE	2SW	TWO-SPEED, ONE-WINDING MOTOR
	ROUND LUMINAIRE RECESSED OR SUSPENDED FROM ABOVE XX = TYPE ON LUMINAIRE SCHEDULE		DISTRIBUTION CLASS PANEL DA = PANEL NAME CHARACTERISTICS AS INDICATED ON ONE LINE DIAGRAM	2SW (A)	TWO-SPEED, TWO-WINDING MOTOR ABANDONED TO REMOVE
	ROUND WALL-MOUNTED LUMINAIRE SUSPENDED FROM SIDE ARM XX = TYPE ON LUMINAIRE SCHEDULE		WEATHER HEAD FOR CONNECTING OVER HEAD CONDUCTORS	A	ALUMINUM
	24"x48" TROFFER LUMINAIRE RECESSED OR SUSPENDED FROM ABOVE XX = TYPE ON LUMINAIRE SCHEDULE		FIRE ALARM MANUAL PULL STATION WITH TAMPER COVER	AF	AMPERE FUSE OR FRAME RATING
	EXTERIOR POLE-MOUNTED AREA LIGHT, NUMBER OF HEADS AND SEPARATION ANGLE AS INDICATED ON PLANS AND LUMINAIRE SCHEDULE XX = TYPE ON LUMINAIRE SCHEDULE		FIRE ALARM SMOKE DETECTOR, CEILING MOUNTED	AFCI	ARC FAULT CIRCUIT INTERRUPTER
	EXIT SIGN WITH DIRECTIONAL ARROWS AS INDICATED, 1 OR 2 FACE, UNIVERSAL MOUNT XI OR X2 = TYPE ON LUMINAIRE SCHEDULE, ALL WITH NICKEL/CADMIUM 90 MINUTE BATTERY BACKUP WITH INTEGRAL TEST SWITCH AND CHARGE INDICATOR LED		FIRE ALARM FIRE-WATER FLOW SWITCH	AFF	ABOVE FINISHED FLOOR
	EMERGENCY EGRESS ONLY LUMINAIRE SURFACE MOUNTED FROM BACK XX = TYPE ON LUMINAIRE SCHEDULE		FIRE ALARM FIRE-WATER TAMPER SWITCH	AFG	ABOVE FINISHED GRADE
	NEMA 5-20R DUPLEX RECEPTACLE, MOUNTED 18" AFF (UON) WP = WEATHER PROOF, GFI = GFCI PROTECTED, IG = ISOLATED GROUND PROVIDE WITH SS-302 COVERPLATE AND CIRCUIT NUMBER		FIRE ALARM AUDIO/VISUAL HORN/STROBE	AL	ALUMINUM
	NEMA 5-20R QUADRAPLEX RECEPTACLE, MOUNTED 18" AFF (UON) WP = WEATHER PROOF, GFI = GFCI PROTECTED, IG = ISOLATED GROUND PROVIDE WITH SS-302 COVERPLATE AND CIRCUIT NUMBER		FIRE ALARM VISUAL STROBE	AU	AMPERE TRIP SETTING
	NEMA 5-20R GFCI PROTECTED RECEPTACLE WITH INTEGRAL TEST AND RESET SWITCH DUPLEX AND QUADRAPLEX AS INDICATED OTHERWISE NOTED, PROVIDE WITH SS-302 COVERPLATE AND CIRCUIT NUMBER		FIRE ALARM SPEAKER	B	BALLAST FACTOR
	SIMPLEX RECEPTACLE, MOUNTED 18" AFF (UON) WITH INDICATED CONFIGURATION (E.G. L6-30R = NEMA TWIST/LOCK, 250 VAC, 30 A) PROVIDE WITH SS-302 COVERPLATE AND CIRCUIT NUMBER		FIRE ALARM CONTROL PANEL	BF	BELOW FINISHED CEILING
	JUNCTION BOX		FIRE ALARM REMOTE ANNUNCIATOR PANEL	BFG	BELOW FINISHED FLOOR
	LIGHT SWITCH RATED 120/277 VAC, MOUNTED 42" AFF (UON), SINGLE-POLE (UON) 2 = 2-POLE, 3 = 3-WAY, 4 = 4-WAY, D = DIMMER, M = MOTOR-RATED W/OUL WP = WEATHER PROOF, R = RED COLOR, K = KEVED, VS = INTEGRAL VACUANCY SENSOR		PUBLIC ADDRESS SPEAKER, CEILING-MOUNTED WALL-MOUNTED VOLUME CONTROL ADJACENT TO LIGHT SWITCH (UON)	C	CIRCUIT
	CEILING OR WALL MOUNTED OCCUPANCY SENSOR LIGHTING CONTROL WITH PASSIVE INFRARED AND ULTRASOUND DUAL TECHNOLOGY, 20 A RATED		PUBLIC ADDRESS SPEAKER, CEILING-MOUNTED	CB	CIRCUIT BREAKER
	TV OUTLET 1-GANG BACKBOX, +42" AFF (UON), SS-302 COVER 1" C WITH PULL STRING ROUTED IN CONDUITS BACK TO SERVER ROOM MEASURED DEVICES AND LOW-VOLTAGE CABLE BY TELECOM CONTRACTOR		PUBLIC ADDRESS INTERCOM CALL BUTTON, WALL-MOUNTED 42" AFF	CC	CONSTANT HORSE POWER (25W MOTOR)
	WALL TELEPHONE OUTLET 1-GANG BACKBOX, +42" AFF (UON), SS-302 COVER 1" C WITH PULL STRING ROUTED IN CONDUITS BACK TO SERVER ROOM MEASURED DEVICES AND LOW-VOLTAGE CABLE BY TELECOM CONTRACTOR		INTRUSION ALARM MOTION DETECTOR	CS	COMBINATION STARTER (25W STARTER / DISCONNECT)
	DEVICES AND LOW-VOLTAGE CABLE BY TELECOM CONTRACTOR. XX - DENOTES NUMBER OF CAT6E CABLES		INTRUSION ALARM NUMERIC KEY-PAD	CT	CONSTANT TORQUE (25W MOTOR)
	EMERGENCY POWER OFF, MUSHROOM HEAD, MAINTAINED CONTACT PUSH BUTTON		INTRUSION ALARM DOOR CONTACTOR	C	COPPER
	PHOTOELECTRIC SENSOR AIMED NORTH		ACCESS CONTROL CARD READER	(D)	EXISTING TO BE DEMOLISHED AND REMOVED
	TIME CLOCK, ASTRONOMIC/MULTI-POLE CONTACTOR		ACCESS CONTROL MAGNETIC DOOR LOCK	DL	DELAY
	POWER COMPANY POWER METER		ACCESS CONTROL DOOR HOLD-OPEN	DS	DISCONNECT SWITCH
	LIGHTING CONTACTOR CHA = CONTACTOR NAME, COIL = COIL CONTROL VOLTAGE, VAC = VOLTAGE RATING, AS = CURRENT RATINGS, P = POLE COUNT, NEMA-# = ENCLOSURE TYPE		VIDEO SURVEILLANCE CCTV CAMERA	(E)	EXISTING TO REMAIN
	CIRCUIT BREAKER, MOLDED-CASE, THERMO-MAGNETIC (UON) VAC = VOLTAGE RATING, AF = FRAME SIZE, AT = TRIP SETTING, P = POLE COUNT, NEMA-# = ENCLOSURE TYPE (WHEN APPLICABLE)		TRANSFORMER + TL = TRANSFORMER NAME TYPE = TRANSFORMER TYPE (E.G. DRY-TYPE, HARMONIC-MITIGATING...) VAC = WINDING VOLTAGES (PRIMARY, SECONDARY), VVA = CONTINUOUS CAPACITY, TAPS = QUANTITY/DEVIATION OF TAPS, RISE + TEMP RISE, INSUL. = INSULATION CLASS, WOUND = WINDING MATERIAL/CONFIGURATION, NEMA-# = ENCLOSURE TYPE	IS	ISOLATED GROUND
	DISCONNECT SWITCH VAC = VOLTAGE RATING, AS = STARTERS, AND OTHER ELECTRICAL EQUIPMENT AF = FUSE SIZE/TYP (E.G. DETD), NF = NON-FUSIBLE P = POLE COUNT, NEMA-# = ENCLOSURE TYPE (WHEN APPLICABLE)		VARIABLE FREQUENCY DRIVE WITH INTEGRAL DISCONNECTING MEANS, VFCI	IS (N)	ISOLATED NEUTRAL
	COMBINATION CIRCUIT BREAKER, MOTOR CONTROLLER, AND THERMAL OVERLOAD VAC = VOLTAGE RATING, AF = FRAME SIZE, AT = TRIP SETTING, NEMA-# = MOTOR STARTER SIZE/TYP (E.G. FVNR), HOA = SELECTOR SWITCH TYPE, P = POLE COUNT, NEMA-# = ENCLOSURE TYPE (WHEN APPLICABLE)		MOTOR, SINGLE OR THREE PHASE HP = HORSE POWER	IS (N)	ISOLATED NEUTRAL
	EQUIPMENT CONNECTION			IS (N)	ISOLATED NEUTRAL

- GENERAL NOTES:
- SYMBOL LEGEND MAY CONTAIN SYMBOLS THAT ARE NOT USED ON ALL DRAWINGS.
 - ABBREVIATION DEFINITIONS ARE NOT COMPREHENSIVE, AND NOT ALL ABBREVIATIONS MAY APPLY TO ALL DRAWINGS. SUBMIT FORMAL REQUEST FOR INFORMATION WHEN ENCOUNTERING CONFLICTS OR AMBIGUOUS SYMBOLS.
 - ALL COVER PLATES FOR RECEPTACLES, SWITCHES, AND DATA SHALL BE SS-302 (UON).
 - PROVIDE DECORA STYLE SWITCHES FOR LIGHT SWITCHES THAT ARE NOT OCCUPANCY SENSOR TYPE.

- COORDINATE WITH CABLING CONTRACTOR FOR CONSTRUCTION SHOP DRAWINGS ALL LOW VOLTAGE DATA CABLES WILL BE ROUTED BACK TO THE CABLE TRAY IN MINIMUM 1" EMT THE CONTRACTOR WILL BE RESPONSIBLE FOR SIZING AND ROUTING UNDER THE FOLLOWING PRETENSES
- CABLE TRAY AND OR WIRE NOT IN CONDUIT IS NOT ALLOWED IN ANY EXPOSED AREAS
 - NO MORE THAN 100' BETWEEN PULL BOXES.
 - NO MORE THAN 270 DEGREES OF TURNS BETWEEN PULL BOXES
 - UTILIZE SWEEPING BENDS
 - PULL BOXES MUST NOT BE USED AS TURNS. THE BEND MUST COME BEFORE OR AFTER THE PULL BOX.
 - ALL EXPOSED CONDUITS ARE TO BE PAINTED PER ARCHITECT COLOR SELECTION
 - CONDUITS/J-BOXES MUST BE LABELED WITH WHAT ROOM NUMBERS THEY ARE FEEDING AND WHAT SYSTEM.
 - CONDUITS SHOULD BE ROUTED AT HIGH LEVEL TO EITHER SIDE OF THE CORRIDOR.
 - ELECTRICAL CONTRACTOR WILL COORDINATE THE SIZES AND ROUTING WITH THE DATA CONTRACTOR AND OTHER TRADES PRIOR TO INSTALLING.
 - ALL CONDUITS WILL BE INSTALLED WITH MEASURED PULL TAPE
 - ALL DATA CABLING WILL BE CAT6 PER SPECIFICATIONS.

- COORDINATE WITH FIRE SPECIFICATIONS AND INSTALLING CONTRACTOR FOR CONSTRUCTION SHOP DRAWINGS ALL EXPOSED (OR ABOVE HARD CEILINGS) LOW VOLTAGE FIRE ALARM WIRING WILL BE ROUTED BACK TO THE FACP ROOM IN EMT CONDUIT. THE CONTRACTOR WILL BE RESPONSIBLE FOR SIZING AND ROUTING; PAINT AND LABEL AS REQUIRED BY ARCHITECT.
- COORDINATE WITH SECURITY SPECIFICATIONS AND INSTALLING CONTRACTOR FOR CONSTRUCTION SHOP DRAWINGS ALL LOW VOLTAGE SECURITY ALARM WIRING WILL BE ROUTED BACK TO THE MDF ROOM IN EMT CONDUIT. THE CONTRACTOR WILL BE RESPONSIBLE FOR SIZING AND ROUTING; PAINT AND LABEL AS REQUIRED BY ARCHITECT.

ELECTRICAL SYMBOL LEGEND



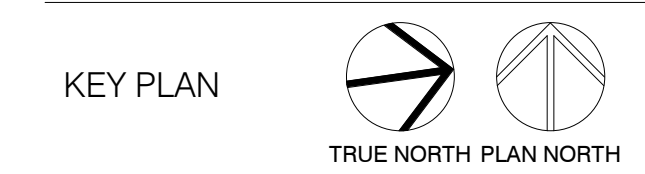
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FORT BEND COUNTY - PRECINCT 3 ANNEX
STADIUM DRIVE & IMPERIAL BLVD
FORT BEND COUNTY, TX

#	Date	ISSUED FOR
01/23/2022	01/23/2022	ISSUE FOR BID, PERMIT, AND CONSTRUCTION



Project Number	21018
Drawn By	JD
Checked By	KT
Approved By	SK
Drawing Title	NOTES AND LEGEND

Drawing Number **E0.00**

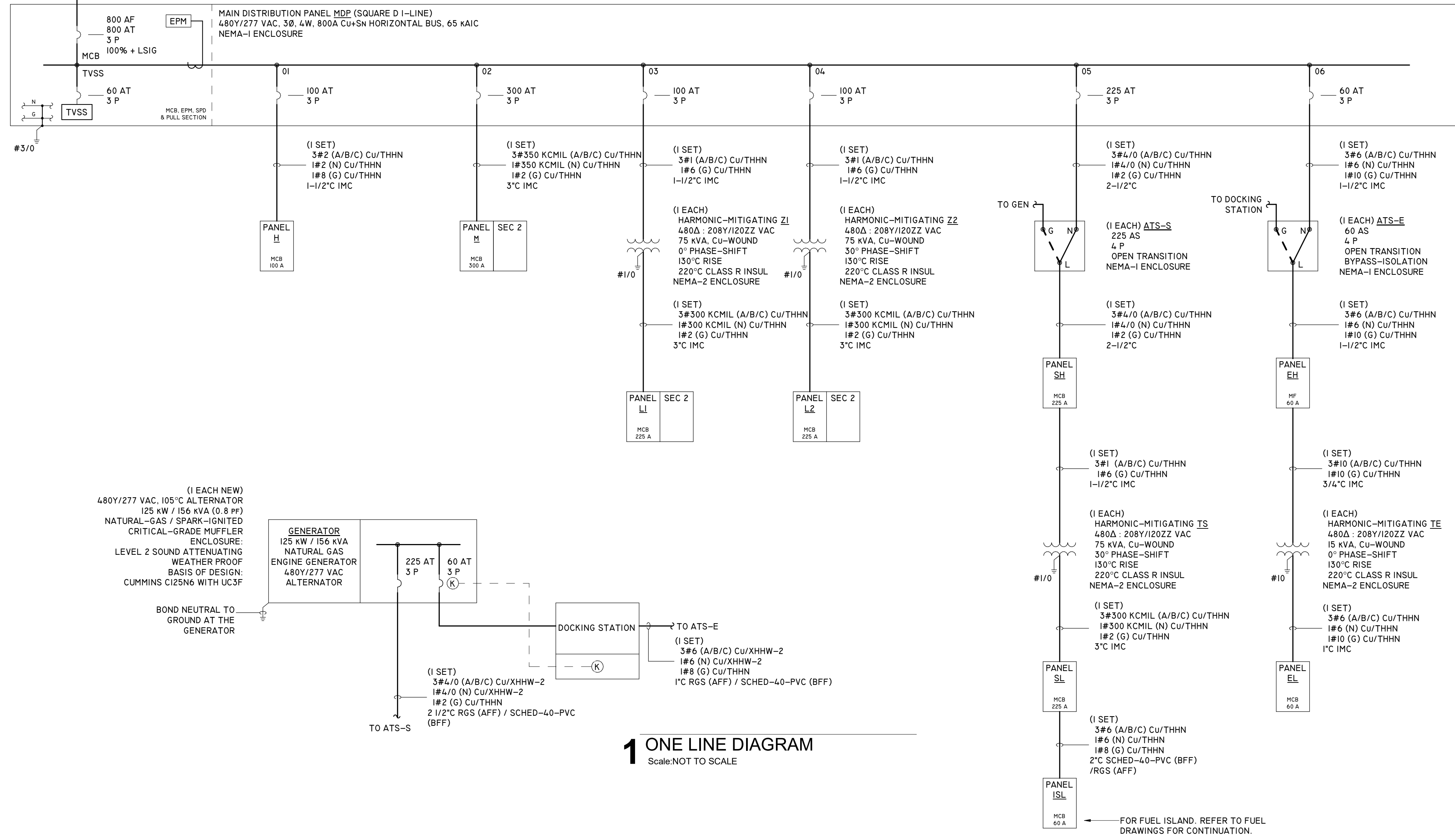
ELECTRICAL CONTRACTOR TO COORDINATE WITH POWER COMPANY AND VERIFY EXACT TERMINAL POLE LOCATION AND ESTABLISH NEW ELECTRICAL SERVICE PER POWER COMPANY STANDARDS

POWER COMPANY PROVIDED POLE-TOP ON NEW TERMINAL POLE 277/480 3Ø, 4W VAC SECONDARY

(2 EACH)
4" RGS SERVICE WEATHER-HEADS

(1 EACH)
BUSSED CT/METER
COORDINATE WITH POWER COMPANY REFER TO DETAIL SHEETS.

(2 SETS)
3#500KCMIL (A/B/C) CU/XHHW-2
1#500KCMIL (N) CU/XHHW-2
4" C SCHED-80-PVC MINIMUM -48" BFG
+ (1) 4" SPARE
MINIMUM 2" RED CONCRETE ENCASED RE: DETAILS



Tag	Capacity (kVA)	System Voltage (VAC)		Conductor Material	Windings				Enclosure		Mounting	Location					
		Primary	Secondary (2Ø/2Ø)		NEMA Insulation Class	Temp Rise (°C)	K Rating	Harmonic	Impedance	NEMA Type			Material				
TE	15.0	480D	208Y/120	COPPER	R	220	130	20	YES	0°	6.5	7.20	2	STEEL	AA	SUSPENDED	ELECTRICAL ROOM 135A
TS	75.0	480D	208Y/120	COPPER	R	220	105	20	YES	30°	3.75	7.20	2	STEEL	AA	CONC PAD	ELECTRICAL ROOM 135A
Z1	75.0	480D	208Y/120	COPPER	R	220	130	20	YES	0°	6.5	7.20	2	STEEL	AA	CONC PAD	ELECTRICAL ROOM 184
Z2	75.0	480D	208Y/120	COPPER	R	220	130	20	YES	30°	6.5	7.20	2	STEEL	AA	CONC PAD	STORAGE 159



Loads Summary Report
Project - FBC Precinct 03 Annex
Comments -

Project Requirements			
Frequency, Hz	: 60.0	Generators Running in Parallel	: 1
Duty	: Standby	Site Altitude, ft(m)	: 361(110)
Voltage	: 277/480, Series Wye	Site Temperature, °C	: 25
Phase	: 3	Max. Atr Temp Rise, °C	: 125
Fuel	: NaturalGas	Project Voltage Distortion Limit, %	: 10
Emissions	: No Preference		

Loads Summary List
*Note: Detailed Loads and Step Report available below

Step No.	Load Name	Quantity	Running		Starting		Peak		Dip Limb, %	VTHD% Limit
			kW	kVA	kW	kVA	kW	kVA		
Step01	Fire Alarm	1	0.87	0.8	0.8	0.8	0.8	0.8	10.0	0.0
Step01	Light Load	1	15.0	15.29	15.0	15.79	None	None	35.0	10.0
Step01	Step Summary		16.0	16.0	16.0	16.6	0.6	0.6	35.0	10.0
Step02	FUEL ISLAND	1	15.0	16.67	15.0	16.67	None	None	35.0	10.0
Step02	Step Summary		15.0	17.0	15.0	17.0	0.6	0.6	35.0	10.0
Step03	General Receptacle Load 1	1	25.0	27.78	25.0	27.78	None	None	35.0	10.0
Step03	AC Unit	1	21.5	24.16	67.5	153.4	None	None	35.0	10.0
Step03	Step Summary		47.0	52.0	93.0	181.0	0.6	0.6	35.0	10.0
Project Summary			Running	Max Starting	Cumulative Step	Cumulative Peak	Project VTHD% Limit			
			kW	kVA	kW	kVA	kW	kVA		
			77.1	85.0	92.5	181.2	123.1	214.2	77.1	85.0

Recommended Generator Report - C125 N6
Project - FBC Precinct 03 Annex
Comments -

Project Requirements			
Frequency, Hz	: 60.0	Generators Running in Parallel	: 1
Duty	: Standby	Site Altitude, ft(m)	: 361(110)
Voltage	: 277/480, Series Wye	Site Temperature, °C	: 25
Phase	: 3	Max. Atr Temp Rise, °C	: 125
Fuel	: NaturalGas	Project Voltage Distortion Limit, %	: 10
Emissions	: No Preference		



Calculated Individual Generator Set Load Running and Peak Requirements

Running kW	Max. Step kW	Cumulative Step kW
: 77.1	: 92.5 In Step 3	: 123.1
Running kVA	Max. Step kVA	Cumulative Step kVA
: 85.0	: 181.2 In Step 3	: 214.2
Running PF	Peak kW	Cumulative Peak kW
: 0.91	: 0.6	: 77.1
Running NLL kVA	Peak kVA	Cumulative Peak kVA
: 15.8	: 0.6	: 85.0
Alternator kW		Pct Rated Capacity
: 84.7		: 61.6

Generator Set Configuration

Alternator	: UC3E	Engine	: QSJB 9G-G2
BCode	: B943	Fuel	: NaturalGas
Excitation	: Shunt	Displacement, cu in. (Litre)	: 543.0(8.9)
Voltage Range	: 220(440-240)480	Cylinders	: 6
Number of Leads	: 6	Altitude Knee, ft(m)	: 5900(1798)
Reconnectable	: Yes	Altitude Slope, % per 885(300.2m)	: 4
Full Single Phase Output	: No	Temperature Knee, °F(°C)	: 1(04)(0)
Increased Motor Starting	: No	Temperature Slope, % per 18°F(10.0°C)	: 2
Extended Stack	: No	Emissions	: EPA NSPS Part 60
		Cooling Package	: -

Set Performance

Running At	Load Requirements
: 61.6% Rated Capacity	
Max. Step Voltage Dip, %	: 17
Max. Step Frequency Dip, %	: 9
Peak Voltage Dip, %	: 1
Peak Frequency Dip, %	: 1
Site Rated Standby kW/kVA	: 125 / 156
Site Rated Max. kW	: 221
Max. kW	: 422
Temp Rise at Full Load, °C	: 120
Voltage Distortion	: 2.4
Site Rated Max Step kW Limit	: -

Recommended Generator Report
08-Nov-2022
Page 1

TYPE	MANUFACTURER	MODEL NUMBER	DESCRIPTION	MOUNTING	LAMP	WATTAGE	VOLTAGE	DIMMABLE	CONTROLS	NOTES
A1	COLUMBIA LIGHTING	LCAT24-35MLG-EDU	2'x4' LED TROFFE	RECESSED	LED	40 W	UNV	0-10V DIMMING		
A1E	COLUMBIA LIGHTING	<VARIES>	<VARIES>	RECESSED	LED	40 W	UNV	0-10V DIMMING		
A2	COLUMBIA LIGHTING	LCAT24-35VLG-EDU	2'x4' LED TROFFE	RECESSED	LED	60 W	UNV	0-10V DIMMING		
A2E	COLUMBIA LIGHTING	LCAT24-35VLG-EDU	2'x4' LED TROFFE	RECESSED	LED	60 W	UNV	0-10V DIMMING		
B1	3G LIGHTING	4RL1-L750-S80-35K-UNV-DIM-GCX-F	RECESSED LINEAR	RECESSED	LED	20 W	UNV	0-10V DIMMING		
B1E	3G LIGHTING	4RL1-L750-S80-35K-UNV-DIM-GCX-F	RECESSED LINEAR	RECESSED	LED	20 W	UNV	0-10V DIMMING		
C1	INTENSE LIGHTING	SDADR-L3-359-D101-VOLT-WF-IC430-HZ-SFW	LED DOWNLIGHT	RECESSED	LED	19 W	UNV	0-10V DIMMING		
C1E	INTENSE LIGHTING	SDADR-L3-359-D101-VOLT-WF-IC430-HZ-SFW	LED DOWNLIGHT - CONNECTED TO EMERGENCY POWER GENERATOR	RECESSED	LED	19 W	UNV	0-10V DIMMING		
C2	INTENSE LIGHTING	SDADR-L3-359-D101-VOLT-WF-IC432-W-SFW-SB	0" LED DOWNLIGHT FIXTURE SUITABLE FOR WET LOCATIONS - EMERGENCY	RECESSED	LED	19 W	UNV	0-10V DIMMING	TC/PC	
C2E	INTENSE LIGHTING	SDADR-L3-359-D101-VOLT-WF-IC432-W-SFW-SB-EM20	0" LED DOWNLIGHT FIXTURE SUITABLE FOR WET LOCATIONS - EMERGENCY	RECESSED	LED	19 W	UNV	0-10V DIMMING	TC/PC	
C3	INTENSE LIGHTING	SDADR-L3-359-D101-VOLT-WF-IC432-W-SFW-CR	0" LED DOWNLIGHT FIXTURE SUITABLE FOR WET LOCATIONS - EMERGENCY	RECESSED	LED	14 W	UNV	0-10V DIMMING	TC/PC	
D1	LUMENWERX	VIA5R-D-HLO-FH-SW-80-500-35-UNV-DI-IC-TXX-W	VIA 5 RECESSED	RECESSED	LED	16 W	UNV	0-10V DIMMING		
F1	COLUMBIA LIGHTING	LXEM4-40ML-RFA-EDU	ENCLOSED AND GASKET LED LIGHT	SURFACE	LED	40 W	UNV	0-10V DIMMING		
F1E	COLUMBIA LIGHTING	LXEM4-40ML-RFA-EDU	ENCLOSED AND GASKET LED LIGHT	SURFACE	LED	40 W	UNV	0-10V DIMMING		
SA1	BEACON	PL-80L-180-4K7-5R-UNV-A-FINISH 7PR-SC	PARKING LOT LIGHTING	LED	LED	180 W	UNV		TC/PC	
SA2	BEACON	PL-80L-235-4K7-4F-UNV-A-FINISH 7PR-SC	PARKING LOT LIGHTING	LED	LED	235 W	UNV		TC/PC	
W1E	COLUMBIA LIGHTING	LN2-12LU-4K-4-DB	WALL PACK	WALL	LED	28 W	UNV		TC/PC	
X	EMERGI-LITE	LXN-XXX	EDGE-LIT EXIT SIGN	WALL/CEILING	LED	10 W	UNV			PROVIDE WITH NUMBER OF FACES AND DIRECTIONAL ARROWS AS SHOWN ON PLANS

LIGHTING NOTES:

- PROVIDE LIGHT FIXTURES IN STAIRWELLS WITH INTEGRAL BATTERY BACKUP, TEST SWITCH, AND GREEN-LED CHARGING INDICATOR FOR EMERGENCY EGRESS OPERATION. THIS IS IN ADDITION TO THEM BEING CIRCUITED TO EMERGENCY LIGHTING PANEL IN AREA.
- ALL LIGHT FIXTURES APPENDED WITH NL (NIGHT LIGHT) SHALL BE NON-SWITCHED AND CONNECTED TO EMERGENCY LIGHTING PANEL CIRCUIT IN AREA.
- ALL LIGHT FIXTURES APPENDED WITH E (EMERGENCY) TO HAVE GENERATOR OR TRANSFER DEVICE FOR AUTOMATIC FULL INTENSITY LIGHTING WHEN NORMAL POWER IS LOST. PROVIDE CONNECTION FROM EMERGENCY LIGHTING PANEL CIRCUIT IN AREA AND UNSWITCHED NORMAL POWER FOR LOSS DETECTION.
- PROVIDE ADDITIONAL, NON-SWITCHED HOT CIRCUIT LEG TO FIXTURE FOR BATTERY CHARGING AND POWER-LOSS DETECTION FOR ALL EMERGENCY EGRESS OR EXIT SIGN FIXTURES AS PART OF BASE BID.
- ALL OUTDOOR LIGHTING FIXTURES REQUIRE CORROSION-RESISTANT OPTION.
- COORDINATE MOUNTING HEIGHT OF ALL FIXTURES WITH ARCHITECTURAL PLANS.
- COORDINATE FINISH OF ALL FIXTURES WITH ARCHITECT PRIOR TO ORDERING.
- REFER TO ARCHITECTURAL PLANS FOR GRID/FLANGE AREAS. PRIOR TO BIDDING OF LIGHT FIXTURES. ORDER CORRECT QUANTITY OF EACH VARIATION.

Description	Qty	Rate	Total
Lighting - Offices (220.12)	26000	1.3	34 kVA
Receptacle - Office (220.14-K)	26000	1	26 kVA
Exterior Lighting	10	3.25	33 kVA
Cooling	80	1	80 kVA
Heating	250	1	250 kVA
Largest Motor	10	0.325	3 kVA
Air Handling Units	15	1.3	20 kVA
Water Heater	20	1	20 kVA
Vehicle Fueling Station	30	1	30 kVA
Total Power			395 kVA
Total Current at 480Y/277 VAC			475 A

Parameter	Symbol	Value	Units
System Voltage	VLL	480	VAC
Phases	np	3	φ
Rated Power	S	500	kVA
Base Impedance	%Z	1.70%	%Z
Impedance Ratio	X/R	10	Ω/Ω

Connection	Source Panel	Target Panel	Conductor		Sats	Length (ft)	Conduit Material	Motors [hp]	Impedance			Fault Current					
			AWG	Material					Feeder [μΩ/ft]	Cumulative [mΩ]	Available [A]	Rating [kA]					
-	UTILITY	MDP	#500	CU	2	150	PVC	-	13.50	19.50	1.44	26.67	4.36	26.31	6.03	31175	35
UTILITY	MDP	H	#2	CU	1	10	IMC	-	200.00	57.00	0.29	27.62	6.36	26.88	4.22	30098	35
MDP	MDP	M	#350	CU	1	10	IMC	-	39.00	50.00	1.28	27.23	4.75	26.81	5.64	30535	35
MDP	MDP	ATS-S	#1/0	CU	1	20	IMC	-	120.00	55.00	0.46	28.23	6.76	27.41	4.05	29449	35
ATS-S	MDP	SH	#1/0	CU	1	10	IMC	-	120.00	55.00	0.46	29.07	7.96	27.96	3.51	28598	35
MDP	MDP	ATS-E	#6	CU	1	20	IMC	-	490.00	64.00	0.13	31.01	14.16	27.59	1.95	26808	35
ATS-E	MDP	E	#6	CU	1	10	IMC	-	490.00	64.00	0.13	34.06	19.06	28.23	1.48	24407	35



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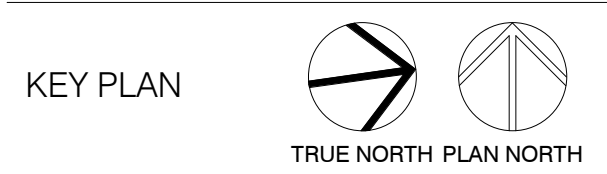


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FORT BEND COUNTY - PRECINCT 3 ANNEX
STADIUM DRIVE & IMPERIAL BLVD
FORT BEND COUNTY, TX

#	Date	ISSUED FOR
01/23/2022	01/23/2022	ISSUE FOR BID, PERMIT, AND CONSTRUCTION



Project Number	21018
Drawn By	JD
Checked By	KT
Approved By	SK
Drawing Title	ONE LINE DIAGRAM
Drawing Number	E0.10

PANEL: L1															
LOCATION: ELEC ROOM															
FED FROM: Z1															
MTG:		X SURFACE		100% NEUTRAL		INT SPD		NEMA		225 A		3		4 WIRE	
FLUSH		BUS:		X SYS GND		FTL		TYPE 1		CU/SN		22		KAIC	
STRUT				ISO GND		FUSIBLE		STEEL		225 A		208Y/120		VOLT	
WIRE SIZE	LOAD DESCRIPTION	LOAD TYPE	TRIP RATE	P	CTK NO	A (kVA)	B (kVA)	C (kVA)	CTK NO	P	TRIP RATE	LOAD TYPE	LOAD DESCRIPTION	WIRE SIZE	
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - RM 107A,112,116,117	R	20	/	1	0.7	0.8		2	1	/	20	Q	* EDF-1, GFCI BREAKER	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	REFRIGERATOR - BREAK ROOM 113	R	20	/	1		1.2	0.7	4	1	/	20	R	RECEPTACLE - BREAK ROOM 113	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 105	R	20	/	1			0.7	6	1	/	20	R	RECEPTACLE - NEMO Q	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - NEMO Q	R	20	/	1	0.2	0.5		8	1	/	20	Q	METAL DETECTOR	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - EXTERIOR	R	20	/	1		0.4	1.5	10	1	/	20	R	COPIER - WORK ROOM 106	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - ELECTRICAL 184	R	20	/	1			0.2	12	1	/	20	R	RECEPTACLE - OFFICE 112	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	COFFEE MACHINE - BREAK ROOM 113	R	20	/	1	1.5	0.4		14	1	/	20	R	FLOOR BOX RECEPTACLE - ROOM 114	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - LIBRARY 108A	R	20	/	1		0.4	0.7	16	1	/	20	R	RECEPTACLE - OFFICE 115	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - COURT ROOM 103	R	20	/	1			0.4	18	1	/	20	R	RECEPTACLE - COURT ROOM 103	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - COURT ROOM 103	R	20	/	1		0.4	0.0	20	1	/	20	Q	HWCP-1	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - EXTERIOR	R	20	/	1			1.1	22	1	/	20	--	SPARE	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - STORAGE 109	R	20	/	1				22	1	/	20	--	SPARE	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - WORKROOM 106	R	20	/	1			0.5	24	1	/	20	R	RECEPTACLE - JURY ROOM 107	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - WORK STATIONS 104	Q	20	/	1	0.5	0.5		26	1	/	20	Q	RECEPTACLE - WORK STATIONS 104	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - WORK STATIONS 104	R	20	/	1		0.5	0.9	28	1	/	20	R	RECEPTACLE - WORK STATIONS 104	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	FLOOR BOX RECEPTACLE - COURT ROOM 103	R	20	/	1			0.7	30	1	/	20	R	RECEPTACLE - WORK STATIONS 104	1-#12, 1-#12, 1-#12, 3/4"
2-#10, 1-#10, 1-#10, 1/2"	CU-1/FCU-1 VIA 30AS/NF/3P/NEMA-3R	M	30	/	2	1.3	0.5		32	1	/	20	R	RECEPTACLE - NEMO Q	1-#12, 1-#12, 1-#12, 3/4"
2-#10, 1-#10, 1-#10, 1/2"	CU-2/FCU-2 VIA 30AS/NF/3P/NEMA-3R	M	30	/	2	1.3	0.4		34	1	/	20	R	RECEPTACLE - COURT ROOM 103	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	HWCP-2	Q	20	/	1		0.0	0.4	36	1	/	20	R	RECEPTACLE - WAITING ROOM 102	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	FLAG LIGHT - VIA TC/PC	Q	20	/	1			1.0	38	1	/	20	R	MICROWAVE - BREAK ROOM 113	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	SPARE	--	20	/	1		0.0	0.4	40	1	/	20	R	RECEPTACLE - NEMO Q	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	FLOOR BOX RECEPTACLE - 107	R	20	/	1		0.4	0.9	42	1	/	20	R	RECEPTACLE	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE	R	20	/	1			0.4	44	1	/	20	R	RECEPTACLE - BAUFF 102A	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - 104A	R	20	/	1		0.4	0.4	46	1	/	20	R	RECEPTACLE - CONFERENCE 114	1-#12, 1-#12, 1-#12, 3/4"
--	SPARE	--	20	/	1		0.0	0.0	48	1	/	20	--	SPARE	1-#12, 1-#12, 1-#12, 3/4"
--	SPARE	--	20	/	1			0.0	50	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1		0.0	0.0	52	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1			0.0	54	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1		0.0	0.0	56	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1			0.0	58	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1		0.0	0.0	60	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1			0.0	62	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1		0.0	0.0	64	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1			0.0	66	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1		0.0	0.0	68	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1			0.0	70	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1		0.0	0.0	72	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1			0.0	74	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1		0.0	0.0	76	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1			0.0	78	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1				80	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1				82	1	/	20	--	SPARE	--
--	SPARE	--	20	/	1				84	1	/	20	--	SPARE	--
Total Load:						10 kVA	11 kVA	9 kVA							
Total Amps:						89 A	90 A	77 A							

PANEL: L2															
LOCATION: ELEC ROOM															
FED FROM: Z2															
MTG:		X SURFACE		100% NEUTRAL		INT SPD		NEMA		225 A		3		4 WIRE	
FLUSH		BUS:		X SYS GND		FTL		TYPE 1		CU/SN		22		KAIC	
STRUT				ISO GND		FUSIBLE		STEEL		225 A		208Y/120		VOLT	
WIRE SIZE	LOAD DESCRIPTION	LOAD TYPE	TRIP RATE	P	CTK NO	A (kVA)	B (kVA)	C (kVA)	CTK NO	P	TRIP RATE	LOAD TYPE	LOAD DESCRIPTION	WIRE SIZE	
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - RESTROOM 138,139	R	20	/	1	0.7	0.7		2	1	/	20	R	RECEPTACLE - OFFICE 172	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	MICROWAVE - BREAK ROOM 171	R	20	/	1		1.5	0.5	4	1	/	20	R	RECEPTACLE - COPY 156	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	COPIER - WORK STATIONS 167	R	20	/	1			1.5	6	1	/	20	R	COPIER - WORK STATIONS 167	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - NEMO Q	R	20	/	1	0.4	0.4		8	1	/	20	R	RECEPTACLE - NEMO Q	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - 168	R	20	/	1		0.5	0.9	10	1	/	20	R	RECEPTACLE - OFFICE 180	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - BREAK ROOM 179	R	20	/	1			0.7	12	1	/	20	--	SPARE	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 177	R	20	/	1	0.7	0.9		14	1	/	20	R	RECEPTACLE - RM 163,174,178,181,182	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - WORK STATION 176	R	20	/	1		1.1	1.1	16	1	/	20	R	RECEPTACLE - WORK STATION 176	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - WORK STATION 176	R	20	/	1			1.1	18	1	/	20	R	RECEPTACLE - WORK STATION 176	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - WORK STATIONS 176	R	20	/	1	0.4	0.7		20	1	/	20	R	RECEPTACLE - WAITING ROOM 175	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	COPIER - COPY 174	R	20	/	1		1.5	0.4	22	1	/	20	R	RECEPTACLE - COPY ROOM 174	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - NEMO Q	R	20	/	1			0.4	24	1	/	20	R	RECEPTACLE - STORAGE 169	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - NEMO Q	R	20	/	1	0.2	0.2		26	1	/	20	R	RECEPTACLE - EXERCISE ROOM 161	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - EXERCISE ROOM 161	R	20	/	1		0.2	0.5	28	1	/	20	R	RECEPTACLE - RESTROOM 154,155	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - STORAGE 162	R	20	/	1			0.4	30	1	/	20	Q	GATE	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - EXERCISE ROOM 161	R	20	/	1	0.2	1.5		32	1	/	20	R	DISHWASHER - BREAK ROOM 179	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - EXERCISE ROOM 161	R	20	/	1		0.2	1.2	34	1	/	20	R	REFRIGERATOR - BREAK ROOM 179	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - BREAK ROOM 171	R	20	/	1			0.7	36	1	/	20	R	MICROWAVE - BREAK ROOM 179	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - EXERCISE ROOM 161	R	20	/	1	0.2	1.2		38	1	/	20	R	REFRIGERATOR - BREAK ROOM 171	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - LOBBY 101	R	20	/	1		0.5	0.3	40	2	/	20	Q	POWER FURNITURE	2-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - EXTERIOR	R	20	/	1			0.4	42	--	--	--	--	--	--
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - NEMO Q	R	20	/	1	0.4	0.9		44	1	/	20	R	RECEPTACLE - WORK STATION 176	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - NEMO Q	R	20	/	1		0.4	0.7	46	1	/	20	R	RECEPTACLE - WORK STATION 176	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - NEMO Q	R	20	/	1			0.2	48	1	/	20	R	RECEPTACLE - WORK STATION 176	1-#12, 1-#12, 1-#12, 3/4"
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE	R	20	/	1	0.4	0.2		50	1	/	20	R	RECEPTACLE	1-#12, 1-#12, 1-#12, 3/4"
--	SPARE	--	20	/	1										

PANEL: SH														
LOCATION: MECH ROOM														
FED FROM:														
WIRE SIZE	LOAD DESCRIPTION	LOAD TYPE	TRIP RATE / P	CKT NO	A (kVA)	B (kVA)	C (kVA)	CKT NO	P / TRIP RATE	LOAD TYPE	LOAD DESCRIPTION	WIRE SIZE		
3-#12, 1-#12, 1-#12, 3/4"	FPT-14 - VIA 30AS/NF/3P/NEMA 1	H	20 / 3	1	0.5	0.5		2	3 / 20	H	FPT-15 - VIA 30AS/NF/3P/NEMA 1	3-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	3				4	--	--	--	--		
--	--	--	--	5				6	--	--	--	--		
3-#12, 1-#12, 1-#12, 3/4"	FPT-16 - VIA 30AS/NF/3P/NEMA 1	H	20 / 3	7	1.4	0.7		8	3 / 20	H	FPT-17 - VIA 30AS/NF/3P/NEMA 1	3-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	9				10	--	--	--	--		
--	--	--	--	11				12	--	--	--	--		
3-#12, 1-#12, 1-#12, 3/4"	FPT-18 - VIA 30AS/NF/3P/NEMA 1	H	20 / 3	13	1.0	1.7		14	3 / 20	H	FPT-19 - VIA 30AS/NF/3P/NEMA 1	3-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	15				16	--	--	--	--		
--	--	--	--	17				18	--	--	--	--		
3-#12, 1-#12, 1-#12, 3/4"	FPT-20 - VIA 30AS/NF/3P/NEMA 1	H	20 / 3	19	1.0	1.7		20	3 / 20	H	FPT-21 - VIA 30AS/NF/3P/NEMA 1	3-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	21				22	--	--	--	--		
--	--	--	--	23				24	--	--	--	--		
3-#12, 1-#12, 1-#12, 3/4"	FPT-22 - VIA 30AS/NF/3P/NEMA 1	H	20 / 3	25	0.6	0.7		26	3 / 20	H	FPT-23 - VIA 30AS/NF/3P/NEMA 1	3-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	27				28	--	--	--	--		
--	--	--	--	29				30	--	--	--	--		
3-#12, 1-#12, 1-#12, 3/4"	FPT-24 - VIA 30AS/NF/3P/NEMA 1	H	20 / 3	31	0.4	19.3		32	3 / 90	H	AHU-1 - VIA 100AS/NF/3P/NEMA 1	3-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	33				34	--	--	--	--		
--	--	--	--	35				36	--	--	--	--		
3-#6, 1-#6, 1-#10, 1"	CJ-1 - VIA 60AS/NF/3P/NEMA 3R	C	60 / 3	37	10.0	2.1		38	1 / 20	L	LIGHTING - OFFICE	1-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	39				40	1 / 20	L	LIGHTING - OFFICE	1-#12, 1-#12, 1-#12, 3/4"		
--	--	--	--	41				42	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	43	0.0	0.0		44	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	45				46	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	47				48	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	49	0.0	0.0		50	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	51				52	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	53				54	1 / 20	--	SPARE	--		
--	SPACE	--	1 / 1	55	--	0.0		56	1 / 20	--	SPARE	--		
--	SPACE	--	1 / 1	57				58	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	59				60	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	61				62	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	63				64	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	65				66	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	67				68	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	69				70	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	71				72	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	73				74	1 / 20	--	SPACE	--		
--	SPACE	--	1 / 1	75				76	1 / 20	--	SPACE	--		
3-#12, 1-#12, 1-#12, 1 1/2"	TRANSFORMER TS - PANEL SL	Spare...	100 / 3	79	22.1	--		80	1 / 20	--	SPACE	--		
--	--	--	--	81				82	1 / 20	--	SPACE	--		
--	--	--	--	83				84	1 / 20	--	SPACE	--		
Total Load:					63 kVA	64 kVA	58 kVA							
Total Amps:					232 A	233 A	209 A							
LOAD ANALYSIS														
LOAD TYPE		CONNECTED	FACTOR	DEMAND		TOTALS								
LIGHTING	L	4729 VA	125.00%	5911 VA										
RECEPTACLE	R	38140 VA	63.11%	24070 VA		CONNECTED LOAD (kVA) 185 kVA								
EQUIPMENT	Q	24500 VA	100.00%	24500 VA		DEMAND LOAD (kVA) 142 kVA								
COOLING	C	30000 VA	0.01%	3 VA		CONNECTED CURRENT (A) 222 A								
HEATING	H	87610 VA	100.00%	87610 VA		DEMAND CURRENT (A) 171 A								
MOTOR	M	0 VA	0.00%	0 VA										
LARGEST MOTOR	G	0 VA	0.00%	0 VA										
KITCHEN	K	0 VA	0.00%	0 VA										
EXISTING	X	0 VA	0.00%	0 VA										

NOTES:
 ALL WIRING FOR 20A/1P CKT. SHALL CONSIST OF 2#12, 1#12G IN 3/4" UNLESS OTHERWISE NOTED.
 * PROVIDE A BREAKER WITH GFCI ** ROUTE CIRCUIT THROUGH LIGHTING CONTACTOR

PANEL: SL														
LOCATION: MECH ROOM														
FED FROM: TS														
WIRE SIZE	LOAD DESCRIPTION	LOAD TYPE	TRIP RATE / P	CKT NO	A (kVA)	B (kVA)	C (kVA)	CKT NO	P / TRIP RATE	LOAD TYPE	LOAD DESCRIPTION	WIRE SIZE		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - MDF 110	R	20 / 1	1	0.4	3.3		2	3 / 60	Q	BUSWAY TRACK - MDF 110	3-#6, 1-#6, 1-#10, 1"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - MDF 110	R	20 / 1	3				4	--	--	--	--		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - MDF 110	R	20 / 1	5				6	--	--	--	--		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - MDF 110	R	20 / 1	7	0.4	0.7		8	1 / 20	R	RECEPTACLE - OFFICE 151	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - ROOM 157	R	20 / 1	9				10	1 / 20	R	RECEPTACLE - OFFICE 149	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 150A	R	20 / 1	11				12	1 / 20	R	RECEPTACLE - ROOM 157	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 146	R	20 / 1	13	0.7	1.3		14	1 / 20	R	RECEPTACLE - 145	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 147	R	20 / 1	15				16	1 / 20	R	RECEPTACLE - OFFICE 144	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 143	R	20 / 1	17				18	1 / 20	R	RECEPTACLE - OFFICE 142	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	COPIER	R	20 / 1	19	1.5	0.7		20	1 / 20	R	RECEPTACLE - OPEN OFFICE 141	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - WOARK AREA 141	R	20 / 1	21				22	1 / 20	R	RECEPTACLE - OFFICE 156	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - RECEPTION 141	R	20 / 1	23				24	1 / 20	R	RECEPTACLE - WAITING ROOM 140	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	GENERATOR	Q	20 / 1	25	0.5	0.5		26	1 / 20	R	RECEPTACLE - WORK AREA 141	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	SEC	Q	20 / 1	27				28	1 / 20	R	RECEPTACLE - ROOM 150	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - BREAKROOM 156	R	20 / 1	29				30	1 / 20	R	RECEPTACLE - COMMAND CENTER 134	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - COMMAND CENTER 135	R	20 / 1	31	0.2	0.4		32	1 / 20	R	RECEPTACLE - BREAK ROOM 121	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 131	R	20 / 1	33				34	1 / 20	R	MICROWAVE - BREAK ROOM 156	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 130	R	20 / 1	35				36	1 / 20	R	RECEPTACLE - OFFICE 129	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - OFFICE 128	R	20 / 1	37	0.7	0.4		38	1 / 20	R	RECEPTACLE - OFFICE 123	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - COPY AND FILE 124	R	20 / 1	39				40	1 / 20	R	RECEPTACLE - OFFICE 127	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - CONFERENCE ROOM 120	R	20 / 1	41				42	1 / 20	R	RECEPTACLE - OFFICE 126	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	COPIER - COPY & FILE 124	R	20 / 1	43	1.5	1.2		44	1 / 20	R	REFRIGERATOR - BREAK ROOM 121	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	MICROWAVE - BREAK ROOM 121	R	20 / 1	45				46	1 / 20	R	COFFEE MACHINE - BREAK ROOM 121	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - RESTROOM 119, 120	R	20 / 1	47				48	1 / 20	R	RECEPTACLE - BREAKROOM 156	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	REFRIGERATOR - BREAK ROOM 156	R	20 / 1	49	1.2	1.5		50	1 / 20	R	COPIER - CIVIL DIVISION 150	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - ROOM 150	Q	20 / 1	51				52	1 / 20	Q	RECEPTACLE - ROOM 150	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	BAS	Q	20 / 1	53				54	1 / 20	R	RECEPTACLE - EXTERIOR	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 1"	HEATER	Q	20 / 1	55	0.5	0.5		56	1 / 20	Q	CHANGER	1-#12, 1-#12, 1-#12, 1"		
1-#12, 1-#12, 1-#12, 1"	ALTERNATOR HEATER	Q	20 / 1	57				58	1 / 20	R	RECEPTACLE - FIRE RISER 183	1-#12, 1-#12, 1-#12, 1"		
1-#12, 1-#12, 1-#12, 3/4"	FLOOR BOX RECEPTACLE - 145	R	20 / 1	59				60	1 / 20	R	FLOOR BOX RECEPTACLE - 134	1-#12, 1-#12, 1-#12, 3/4"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE - MECH 135	R	20 / 1	61	0.4	0.4		62	1 / 20	R	FLOOR BOX RECEPTACLE - CONFERENCE 120	1-#12, 1-#12, 1-#12, 1"		
1-#12, 1-#12, 1-#12, 3/4"	RECEPTACLE	R	20 / 1	63				64	1 / 20	Q	RAIN CONTROLLER	1-#12, 1-#12, 1-#12, 3/4"		
--	SPARE	--	20 / 1	65				66	1 / 20	R	RECEPTACLE - MECH 135	1-#12, 1-#12, 1-#12, 3/4"		
--	SPARE	--	20 / 1	67	0.0	0.0		68	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	69				70	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	71				72	1 / 20	--	SPARE	--		
--	SPARE	--	20 / 1	73	0.0	0.0		74	1 / 20	--	SPARE	--		
--	SPACE													

