

CITY OF ANN ARBOR
INVITATION TO BID



Steere Farm Engine Replacement Project

ITB No. 4440

Due Date: May 19, 2016 at 2:00 p.m. (Local Time)

Public Services Area/Water Treatment Services Unit
Administering Service Area/Unit

Issued By:

City of Ann Arbor
Procurement Unit
301 E. Huron Street
Ann Arbor, MI 48104

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**ADVERTISEMENT
FOR STEERE FARM ENGINE REPLACEMENT PROJECT
CITY OF ANN ARBOR
BID NO. ITB No. 4440**

Sealed Bids will be received by the City of Ann Arbor Procurement Unit, 301 East Huron Street, c/o Customer Service, 1st Floor, Larcom City Hall, on or before **May 19, 2016 by 2:00 PM (Local Time)** for the construction of **Steere Farm Engine Replacement Project**. Bids will be publically opened and read aloud at this time.

A pre-bid conference will be held on **May 3, 2016 at 10:00 a.m. at 919 Sunset Road, Ann Arbor, MI followed by a site visit**. Attendance is **highly** recommended.

Work to be done includes **Installation of electrical service, construction of underground duct bank, installation of electric motors, installation of variable frequency drives, construction of new well house buildings, completion of masonry work, installation of back-up generator, site work and related work.**

Bid documents, specifications, and addenda, with the exception of the Plans, shall be downloaded by bidders at either of the following websites: Michigan Inter-governmental Trade Network (MITN) www.mitn.info or City of Ann Arbor Purchasing website: www.A2gov.org. It is the bidder's responsibility to verify they have obtained all information before submitting a bid.

Each Bid shall be accompanied by a certified check, or Bid Bond by a surety authorized to transact business in Michigan, in the amount of 5% of the total of the bid price. A Bid, once submitted, becomes the property of the City. In the sole discretion of the City, the City reserves the right to allow a bidder to reclaim submitted documents provided the documents are requested and retrieved no later than 48 hours prior to the scheduled bid opening.

The successful Bidder will be required to furnish satisfactory performance and labor and material bonds in the amount of 100% of the bid price. The form of the Performance Bond and labor and materials bond is attached hereto. The successful Bidder will be required to provide satisfactory insurance coverage, including evidence of endorsement prior to issuance of a Notice to Proceed.

Precondition for entering into a Contract with the City of Ann Arbor is compliance with the wage and employment requirements of Chapter 14 of Title I of the Code of City of Ann Arbor and Chapter 112 of Title IX of the Code of the City of Ann Arbor. Employees whose wage level are subject to federal or state prevailing wage law must be paid in accordance with their U.S. Department of Labor wage rate classification (see www.wdol.gov) The wage determination(s) current on the date 10 days before bids are due shall apply to this contract.

Employees whose wage level are not otherwise subject to federal or state prevailing wage law, must be pay a living wage in accordance with Chapter 112 of the City Code. The successful Bidder may also be required to comply with Chapter 23 of Title I of the Code of the City of Ann Arbor. Further information is outlined in the Contract Documents. All bidders are required to complete and submit the City of Ann Arbor Conflict of Interest Disclosure Form with the bid.

After the time of opening, no Bid may be withdrawn for a period of **one hundred twenty (120)**

days. The City reserves the right to accept any Bid, to reject any or all Bids, to waive irregularities and/or informalities in any Bid, and to make the award in any manner the City believes to be in its best interest.

Technical questions regarding this project may be submitted in writing to **Brian Rubel (brian.rubel@tetrattech.com)**. Questions by telephone call are prohibited. The deadline for questions shall be **May 9, 2016 at 5:00 p.m.** Questions will not be accepted after this date.

The City reserves the right to accept any Bid, to reject any or all Bids, to waive irregularities and/or informalities in any Bid, and to make the award in any manner the City believes to be in its best interest.

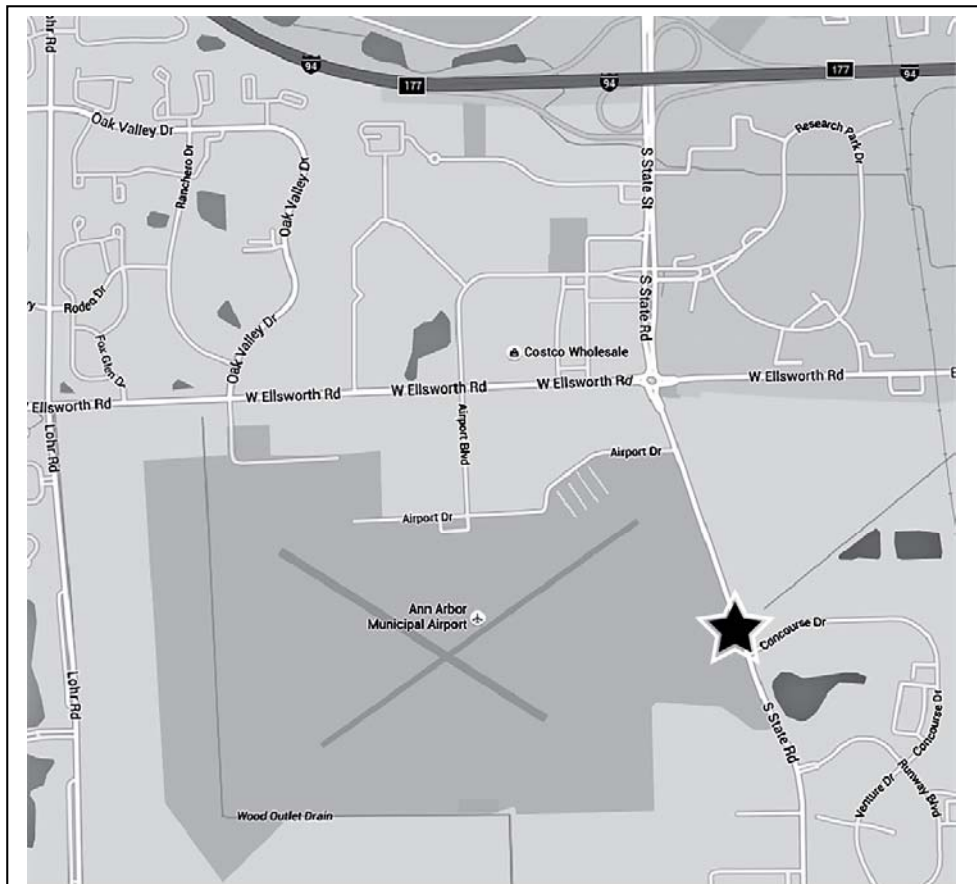
Any further information on bid documents may be obtained from the Procurement Office, (734) 794-6500.

CITY OF ANN ARBOR PROCUREMENT UNIT

NOTICE OF PRE-BID CONFERENCE

A pre-bid conference for this project will be held on **May 3, 2016 at 10:00 a.m.** at **919 Sunset Road, Ann Arbor, MI.** A site visit (**4350 S. State Street, Ann Arbor, MI 48108**) will follow the prebid conference to allow potential bidders the opportunity to view the project site. This will be the only opportunity to view the project site.

Attendance at this conference is highly recommended. Administrative and technical questions regarding this project will be answered at this time. The pre-bid conference is for information only. Any answers furnished will not be official until verified in writing by the Financial Service Area, Procurement Unit. Answers that change or substantially clarify the bid will be affirmed in an addendum.



Map to Site Visit

Entry to site is between hangar buildings on the west side of South State Street.

INSTRUCTIONS TO BIDDERS

General

Work to be done under this Contract is generally described through the detailed specifications and must be completed fully in accordance with the contract documents. All work to be done under this Contract is located in or near the City of Ann Arbor.

Any Bid which does not conform fully to these instructions may be rejected.

Preparation of Bids

Bids should be prepared providing a straight-forward, concise description of the Bidder's ability to meet the requirements of the ITB. Bids shall be written in ink or typewritten. No erasures are permitted. Mistakes may be crossed out and corrected and must be initialed and dated in ink by the person signing the Bid.

Bids must be submitted on the "Bid Forms" provided with each blank properly filled in. If forms are not fully completed it may disqualify the bid. No alternative bid will be considered unless alternative bids are specifically requested. If alternatives are requested, any deviation from the specification must be fully described, in detail on the "Alternate" section of Bid form.

Each person signing the Bid certifies that he/she is the person in the Bidder's firm/organization responsible for the decision as to the fees being offered in the Bid and has not and will not participated in any action contrary to the terms of this provision.

Questions or Clarification on ITB Specifications

All questions regarding this ITB shall be submitted via email. Emailed questions and inquires will be accepted from any and all prospective Bidders in accordance with the terms and conditions of the ITB.

All questions shall be due on or before **May 9, 2016 at 5:00 PM Local Time** and should be addressed as follows:

Specification/Scope of Work questions emailed to brian.rubel@tetrattech.com.
Bid Process and HR Compliance questions emailed to cspencer@a2gov.org

Any error, omissions or discrepancies in the specification discovered by a prospective contractor and/or service provider shall be brought to the attention of **Colin Spencer** at cspencer@a2gov.org after discovery as possible. Further, the contractor and/or service provide shall not be allowed to take advantage of errors, omissions or discrepancies in the specifications.

Addenda

If it becomes necessary to revise any part of the ITB, notice of the Addendum will be posted to Michigan Inter-governmental Trade Network (MITN) www.mitn.info and/or City of Ann Arbor web site www.A2gov.org for all parties to download.

Each Bidder must in its Bid, to avoid any miscommunications, acknowledge all addenda which it

has received, but the failure of a Bidder to receive, or acknowledge receipt of; any addenda shall not relieve the Bidder of the responsibility for complying with the terms thereof.

The City will not be bound by oral responses to inquiries or written responses other than written addenda.

Bid Submission

All Bids are due and must be delivered to the City of Ann Arbor Procurement Unit on or before **May 19, 2016 at 2:00 p.m.** Bids submitted late or via oral, telephonic, telegraphic, electronic mail or facsimile **will not** be considered or accepted.

Each Bidder must submit one (1) original Bid and two (2) Bid copies in a sealed envelope clearly marked: **ITB No. 4440 – Steere Farm Engine Replacement Project.**

Bids must be addressed and delivered to:

City of Ann Arbor
Procurement Unit,
c/o Customer Services, 1st Floor
301 East Huron Street
P.O. Box 8647
Ann Arbor, MI 48104

All Bids received on or before the Due Date will be publicly opened and recorded immediately. No immediate decisions are rendered.

The following forms provided within this ITB Document must be included in submitted bids.

- City of Ann Arbor Prevailing Wage Declaration of Compliance
- City of Ann Arbor Living Wage Ordinance Declaration of Compliance
- Vendor Conflict of Interest Disclosure Form\
- City of Ann Arbor Non-Discrimination Ordinance Declaration of Compliance

Bids that fail to provide these completed forms listed above upon bid opening will be rejected as non-responsive and will not be considered for award.

Hand delivered bids will be date/time stamped/signed by the Procurement Unit at the address above in order to be considered. Normal business hours are 9:00 a.m. to 3:00 p.m. Monday through Friday, excluding Holidays. The City will not be liable to any Bidder for any unforeseen circumstances, delivery or postal delays. Postmarking to the Due Date will not substitute for receipt of the Bid. Each Bidder is responsible for submission of their Bid.

Additional time for submission of bids past the stated due date and time will not be granted to a single Bidder; however, additional time may be granted to all Bidders when the City determines in its sole discretion that circumstances warrant it.

Award

The City intends to award a Contract(s) to the lowest responsible Bidder(s). On multi-divisional contracts, separate divisions may be awarded to separate Bidders. The City may also utilize alternatives offered in the Bid Forms, if any, to determine the lowest responsible Bidder on each

division, and award multiple divisions to a single Bidder, so that the lowest total cost is achieved for the City. For unit price bids, the Contract will be awarded based upon the unit prices and the lump sum prices stated by the bidder for the work items specified in the bid documents, with consideration given to any alternates selected by the City. If the City determines that the unit price for any item is materially different for the work item bid than either other bidders or the general market, the City, in its sole discretion, in addition to any other right it may have, may reject the bid as not responsible or non-conforming.

The acceptability of major subcontractors will be considered in determining if a Bidder is responsible. In comparing Bids, the City will give consideration to alternate Bids for items listed in the bid forms. All key staff and subcontractors are subject to the approval by the City.

Qualifications

The City will evaluate Bids based on cost as well as experience. Contractors that have not included the required list of similar work experience, resumes for project manager and superintendent, and associated references in Section 5 of the Bid Form may have their bid rejected.

As part of the bid, Bidders shall provide documentation that the Bidder's company has at least 10 years of experience providing construction of water and wastewater facilities. Bidders shall also submit, for the proposed Project Manager and Superintendent, resumes documenting 7 years of professional experience for each individual in the construction industry as a full-time employee, along with 3 references for each individual from previous projects completed within the past 5 years. Bidders shall also submit the attached form, "Section 5 – References," which identifies a minimum of three projects completed in the past five years at water or wastewater facilities, including construction cost, contractor and subcontractor information, that demonstrate similar work experience and complexity to that included within these contract documents, specifically concrete foundations, building construction, underground electrical and instrumentation and control work at water and wastewater facilities.

All key staff and subcontractors are subject to approval by the City.

Official Documents

The City of Ann Arbor officially distributes bid documents from the Procurement Unit or through the Michigan Intergovernmental Trade Network (MITN). Copies of the bid documents obtained from any other source are not Official copies. Addenda and other bid information will only be posted to these official distribution sites. If you obtained City of Ann Arbor Bid documents from other sources, it is recommended that you register on www.MITN.info and obtain an official Bid.

Bid Security

Each bid must be accompanied by a certified check, or Bid Bond by a surety licensed and authorized to do business within the State of Michigan, in the amount of 5% of the total of the bid price.

Withdrawal of Bids

After the time of opening, no Bid may be withdrawn for the period of One Hundred Twenty (120) days as specified in the Advertisement.

Contract Time

Time is of the essence in the performance of the work under this Contract. The available time for work under this Contract is indicated on page C-2, Article III of the Contract. If these time requirements cannot be met, the Bidder must stipulate on Bid Form Section 3 - Time Alternate its schedule for performance of the work. Consideration will be given to time in evaluating bids.

Liquidated Damages

A liquidated damages clause, as given on page C-2, Article III of the Contract, provides that the Contractor shall pay the City as liquidated damages, and not as a penalty, a sum certain per day for each and every day that the Contractor may be in default of completion of the specified work, within the time(s) stated in the Contract, or written extensions.

Liquidated damages clauses, as given in the General Conditions, provide further that the City shall be entitled to impose and recover liquidated damages for breach of the obligations under Chapter 112 of the City Code.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

Human Rights Information

All contractors proposing to do business with the City shall satisfy the contract compliance administrative policy adopted by the City Administrator in accordance with the Section 9:158 of the Ann Arbor City Code. Breach of the obligation not to discriminate as outlined in Section 5, beginning at page GC-3 shall be a material breach of the contract. Contractors are required to post a copy of Ann Arbor's Non-Discrimination Ordinance attached at all work locations where its employees provide services under a contract with the City.

Wage Requirements

Section 4, beginning at page GC-2, outlines the requirements for payment of prevailing wages or of a "living wage" to employees providing service to the City under this contract. The successful bidder must comply with all applicable requirements and provide documentary proof of compliance when requested.

For laborers whose wage level are subject to federal or state prevailing wage law the appropriate Davis-Bacon wage rate classification is identified based upon the work including within this contract. **The wage determination(s) current on the date 10 days before bids are due shall apply to this contract.** The U.S. Department of Labor (DOL) has provided explanations to assist with classification in the following resource link: www.wdol.gov

Conflict Of Interest Disclosure

The City of Ann Arbor Purchasing Policy requires that prospective Vendors complete a Conflict of Interest Disclosure form. A contract may not be awarded to the selected Vendor unless and until the Procurement Unit and the City Administrator have reviewed the Disclosure form and determined that no conflict exists under applicable federal, state, or local law or administrative regulation. Not every relationship or situation disclosed on the Disclosure Form may be a disqualifying conflict. Depending on applicable law and regulations, some contracts may awarded on the recommendation of the City Administrator after full disclosure, where such action is allowed by law, if demonstrated competitive pricing exists and/or it is determined the award is in the best interest of the City. A copy of the Vendor Conflict of Interest Disclosure Form is attached.

Major Subcontractors

The Bidder shall identify on Bid Form Section 4 each major subcontractor it expects to engage for this Contract if the work to be subcontracted is 15% or more of the bid sum or over \$50,000, whichever is less. The Bidder also shall identify the work to be subcontracted to each major subcontractor. The Bidder shall not change or replace a subcontractor without approval by the City.

Debarment

Submission of a Bid in response to this ITB is certification that the Bidder is not currently debarred, suspended, proposed for debarment, and declared ineligible or voluntarily excluded from participation in this transaction by any State or Federal departments or agency. Submission is also agreement that the City will be notified of any changes in this status.

Disclosures

After bids are opened, all information in a submitter's bid is subjected to disclosure under the provisions of Michigan Public Act No. 442 of 1976, as amended (MCL 15.231 et seq.) known as the "Freedom of Information Act." The Freedom of Information Act also provides for the complete disclosure of contracts and attachments thereto except where specifically exempted.

Bid Protest

All Bid protests must be in writing and filed with the Purchasing Agent within five (5) business days of the award action. The bidder must clearly state the reasons for the protest. If a bidder contacts a City Service Area/Unit and indicates a desire to protest an award, the Service Area/Unit shall refer the bidder to the Purchasing Agent. The Purchasing Agent will provide the bidder with the appropriate instructions for filing the protest. The protest shall be reviewed by the City Administrator or designee whose decision shall be final.

Cost Liability

The City of Ann Arbor assumes no responsibility or liability for costs incurred by the Bidder prior to the execution of a contract with the City. By submitting a bid, a bidder agrees to bear all costs incurred or related to the preparation, submission and selection process for the bid.

Reservation of Rights

The City of Ann Arbor reserves the right to accept any bid or alternative bid proposed in whole or in part, to reject any or all bids or alternatives bids in whole or in part and to waive irregularity and/or informalities in any bid and to make the award in any manner deemed in the best interest of the City.

SUPPLEMENTAL INSTRUCTIONS TO BIDDERS

Bidders shall submit with their Bid, responses to the following. Responses shall be prepared to numerically match the itemized list as follows:

1. Bidder shall submit a formal/written safety program.
2. Bidder shall describe the job site safety program for this project and specific safety policies in which employees must be in compliance.
3. Bidder shall provide the organizations most current OSHA 300 logs or reasons why this organization is exempt from OSHA 300 reporting.
4. Bidder shall provide the organization's most recent OSHA recordable incident rate, DART rate, and lost workday rate.
5. If applicable, bidder shall provide the organization's excavation and trench safety program. Within this program, please identify the organization's Qualified Person for excavation and trench safety that will be on-site daily.
6. Bidder shall identify the project safety team, their qualifications, duties and city(s) of residence.

Bidder shall identify any major accidents or incidents that resulted in major injury or deaths that have occurred on a project site controlled by the firm, or any subcontractor(s) (at any contractual level), that had any major injury or death on a project site? If so, describe how the organization has revised the program.

INVITATION TO BID

City of Ann Arbor
Guy C. Larcom Municipal Building
Ann Arbor, Michigan 48107

Ladies and Gentlemen:

The undersigned, as Bidder, declares that this Bid is made in good faith, without fraud or collusion with any person or persons bidding on the same Contract; that this Bidder has carefully read and examined the bid documents, including Advertisement, City Nondiscrimination and Wage requirements, Vendor Conflict of Interest Form, Notice of Pre-Bid Conference, Instructions to Bidders, Bid, Bid Forms, Contract, Bond Forms, General Conditions, Standard Specifications, Detailed Specifications, all Addenda, and the Plans (if applicable) and understands them. The Bidder declares that it conducted a full investigation at the site and of the work proposed and is fully informed as to the nature of the work and the conditions relating to the work's performance. The Bidder also declares that it has extensive experience in successfully completing projects similar to this one.

The Bidder acknowledges that it has not received or relied upon any representations or warrants of any nature whatsoever from the City of Ann Arbor, its agents or employees, and that this Bid is based solely upon the Bidder's own independent business judgment.

The undersigned proposes to perform all work shown on the plans or described in the bid documents, including any addenda issued, and to furnish all necessary machinery, tools, apparatus, and other means of construction to do all the work, furnish all the materials, and complete the work in strict accordance with all terms of the Contract of which this Bid is one part.

In accordance with these bid documents, and Addenda numbered _____, the undersigned, as Bidder, proposes to perform at the sites in and/or around Ann Arbor, Michigan, all the work included herein for the amounts set forth in the Bid Forms.

The Bidder declares that it has become fully familiar with the liquidated damage clauses for completion times and for compliance with City Code Chapter 112, understands and agrees that the liquidated damages are for the non-quantifiable aspects of non-compliance and do not cover actual damages that may be shown and agrees that if awarded the Contract, all liquidated damage clauses form part of the Contract.

The Bidder declares that it has become fully familiar with the provisions of Chapter 14, Section 1:319 (Prevailing wages) and Chapter 23 (Living Wage) of the Code of the City of Ann Arbor and that it understands and agrees to comply, to the extent applicable to employees providing services to the City under this Contract, with the wage and reporting requirements stated in the City Code provisions cited. Bidder further agrees that the cited provisions of Chapter 14 and Chapter 23 form a part of this Contract.

The Bidder declares that it has become familiar with the City Conflict of Interest Disclosure Form and certifies that the statement contained therein is true and correct.

The Bidder encloses a certified check or Bid Bond in the amount of 5% of the total of the Bid Price. The Bidder agrees both to contract for the work and to furnish the necessary Bonds and insurance documentation within 10 days after being notified of the acceptance of the Bid.

If this Bid is accepted by the City and the Bidder fails to contract and furnish the required Bonds and insurance documentation within 10 days after being notified of the acceptance of this Bid, then the Bidder shall be considered to have abandoned the Contract and the certified check or Bid Bond accompanying this Bid shall become due and payable to the City.

If the Bidder enters into the Contract in accordance with this Bid, or if this Bid is rejected, then the accompanying check or Bid Bond shall be returned to the Bidder.

In submitting this Bid, it is understood that the right is reserved by the City to accept any Bid, to reject any or all Bids, to waive irregularities and/or informalities in any Bid, and to make the award in any manner the City believes to be in its best interest.

SIGNED THIS _____ DAY OF _____, 2016.

Bidder's Name

Authorized Signature of Bidder

Official Address

(Print Name of Signer Above)

Telephone Number

Email Address for Award Notice

LEGAL STATUS OF BIDDER

(The Bidder shall fill out the appropriate form and strike out the other three.)

Bidder declares that it is:

* A corporation organized and doing business under the laws of the State of _____, for whom _____, bearing the office title of _____, whose signature is affixed to this Bid, is authorized to execute contracts.

NOTE: If not incorporated in Michigan, please attach the corporation's Certificate of Authority

• A limited liability company doing business under the laws of the State of _____, whom _____ bearing the title of _____ whose signature is affixed to this proposal, is authorized to execute contract on behalf of the LLC.

* A partnership, organized under the laws of the state of _____ and filed in the county of _____, whose members are (list all members and the street and mailing address of each) (attach separate sheet if necessary):

* An individual, whose signature with address, is affixed to this Bid: _____ (initial here)

Authorized Official

_____ **Date** _____, 2016

(Print) Name _____ Title _____

Company: _____

Address: _____

Contact Phone () _____ Fax () _____

Email _____

BID FORM

Section 1 – Schedule of Prices

Project: Steere Farm Engine Replacement Project, ITB # 4440

Bidder' Name: _____

Notes:

1. All bidders shall provide a Unit Price and Total Price for all bid items specified.
2. Quantities included in the bid table represent estimated quantities for different work. The CONTRACTOR shall be compensated for the actual number of items completed using the unit prices provided.
3. The City, at its sole discretion, may elect to delete any portion of the work delineated below, with no change to the unit prices provided. Work shall be determined based upon the availability of funds.
4. Any item not provided in the following list shall be considered incidental.
5. Contract shall be awarded based on the base bid or any combination of a base bid and alternate bid in any manner the City believes to be in its best interest.

Bid Items

The bidder agrees to complete the Project and all related work, as specified and shown on the drawings, for the following unit prices.

Steere Farm Engine Replacement Project BASE BID					
Item No.	Item Description	Qty	Unit	Unit Price	Total Price
1	DTE Electrical Allowance	1	LS	\$70,000	\$70,000
2	Permit Allowance	1	LS	\$20,000	\$20,000
3	Relocate Gas Main Allowance	1	LS	\$40,000	\$40,000
4	Mobilization	1	LS	\$	\$
5	Well houses 25W, 21W, 741 and All Related Work	1	LS	\$	\$
6	Start-Up, Commissioning and Training	1	LS	\$	\$
7	Final Closeout	1	LS	\$	\$

Total Base Bid: _____ Dollars (\$_____)

(Amount shall be shown in both words and figures. In case of a discrepancy, the amount shown in words shall govern.)

Alternates

Alternate No. 1 – Kohler Generator - to provide a Kohler Generator in lieu of Cummins Generator

Add: _____ Dollars (_____) or

Deduct: _____ Dollars (_____)

Alternate No. 2 – Salvage Engines - to remove existing Caterpillar Engines and leave on site for disposal by City of Ann Arbor

Add: _____ Dollars (_____) or

Deduct: _____ Dollars (_____)

Alternate No. 3 – Eliminate Masonry Wall - to eliminate masonry knee wall and use insulated steel siding at all three well houses

Deduct: _____ Dollars (_____)

Alternate No. 4 – Eliminate Epoxy Floor Coatings - to eliminate epoxy floor coatings and apply concrete sealer at all three well houses

Deduct: _____ Dollars (_____)

Alternate No. 5 – Eliminate Trench Drains – to eliminate trench drains, sumps and sump pumps in buildings 21W and 741.

Deduct: _____ Dollars (_____)

Alternate No. 6 – Eliminate Water Supply Taps and Hose Bibbs – to eliminate water supply taps downstream of the check valve and instead install these taps upstream of the check valves

Deduct: _____ Dollars (_____)

Alternate No. 7 – Provide Manufacturer Remote Training Classes – Provide remote training classes for VFD and generator (two classes).

Add: _____ Dollars (_____)

Alternate No. 8 – Facility Online Training – Provide online training material per specification section 01830.

Add: _____ Dollars (_____)

BID FORM

Section 2 - Material and Equipment Alternates

The Base Bid proposal price shall include materials and equipment selected from the designated items and manufacturers listed in the bidding documents. This is done to establish uniformity in bidding and to establish standards of quality for the items named.

If the Contractor wishes to quote alternate items for consideration by the City, it may do so under this Section. A complete description of the item and the proposed price differential must be provided. Unless approved at the time of award, substitutions where items are specifically named will be considered only as a negotiated change in Contract Sum.

<u>Item Number</u>	<u>Description</u>	<u>Add/Deduct Amount</u>
--------------------	--------------------	--------------------------

If the Bidder does not suggest any material or equipment alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any material or equipment alternate under the Contract.

Signature of Authorized Representative of Bidder _____

BID FORM

Section 3 - Time Alternate

If the Bidder takes exception to the time stipulated in Article III of the Contract, Time of Completion, page C-2, it is requested to stipulate below its proposed time for performance of the work. Consideration will be given to time in evaluating bids.

If the Bidder does not suggest any time alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any time alternate under the Contract.

Signature of Authorized Representative of Bidder _____

BID FORM

Section 4 - Major Subcontractors

For purposes of this Contract, a Subcontractor is anyone (other than the Contractor) who performs work at or about the construction site, directly or indirectly for or on behalf of the Contractor (and whether or not in privity of Contract with the Contractor), but shall not include any individual who furnishes merely the individual's own personal labor or services.

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision to Section 4 of the General Conditions covering subcontractor's employees who perform work on this contract.

For the work outlined in these documents the Bidder expects to engage the following major subcontractors to perform the work identified:

<u>Subcontractor (Name and Address)</u>	<u>Work</u>	<u>Amount</u>
	Site/earthwork	
	Concrete	
	Painting	
	Electrical	
	Mechanical	
	Masonry	
	Process Piping	
	Controls	
	Surveyor	
	Materials Testing	
	Other	

The bidder expects to supply products from the following manufacturers:

<u>Supplier (manufacturer)</u>	<u>Product</u>
	Generator
	200 HP Electric Motors
	Variable Frequency Drives
	Motor Control Center
	Online Training Provider
	Pre-Engineered Building

If the Bidder does not expect to engage any major subcontractor, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT expect to engage any major subcontractor to perform work under the Contract.

Signature of Authorized Representative of Bidder _____

BID FORM

Section 5 – References

ELECTRICAL CONTRACTOR (Name: _____)

Include a minimum of 3 references from similar projects involving building construction at water utility facilities completed within the past 5 years.

[Refer also to Instructions to Bidders for additional requirements, if any]

1) _____
 Project Name Cost Date Constructed

_____ _____
 Contact Name Phone Number

2) _____
 Project Name Cost Date Constructed

_____ _____
 Contact Name Phone Number

3) _____
 Project Name Cost Date Constructed

_____ _____
 Contact Name Phone Number

BID FORM

Section 5 – References

CONTROLS CONTRACTOR (Name: _____)

Include a minimum of 3 references from similar projects involving building construction at water utility facilities completed within the past 5 years.

[Refer also to Instructions to Bidders for additional requirements, if any]

1) _____
Project Name Cost Date Constructed

_____ _____
Contact Name Phone Number

2) _____
Project Name Cost Date Constructed

_____ _____
Contact Name Phone Number

3) _____
Project Name Cost Date Constructed

_____ _____
Contact Name Phone Number

BID FORM

Section 5 – References

MECHANICAL CONTRACTOR (Name:_____)

Include a minimum of 3 references from similar projects involving building construction at water utility facilities completed within the past 5 years.

[Refer also to Instructions to Bidders for additional requirements, if any]

1) _____
Project Name Cost Date Constructed

_____ _____
Contact Name Phone Number

2) _____
Project Name Cost Date Constructed

_____ _____
Contact Name Phone Number

3) _____
Project Name Cost Date Constructed

_____ _____
Contact Name Phone Number

SAMPLE STANDARD CONTRACT

If a contract is awarded, the selected contractor will be required to adhere to a set of general contract provisions which will become a part of any formal agreement. These provisions are general principles which apply to all contractors of service to the City of Ann Arbor such as the following:

CONTRACT

THIS AGREEMENT is made on the _____ day of _____, 2016, between the CITY OF ANN ARBOR, a Michigan Municipal Corporation, 301 East Huron Street, Ann Arbor, Michigan 48104 ("City") and _____ ("Contractor")

(An individual/partnership/corporation, include state of incorporation) (Address)

Based upon the mutual promises below, the Contractor and the City agree as follows:

ARTICLE I - Scope of Work

The Contractor agrees to furnish all of the materials, equipment and labor necessary; and to abide by all the duties and responsibilities applicable to it for the project titled "Steere Farm Engine Replacement Project" in accordance with the requirements and provisions of the following documents, including all written modifications incorporated into any of the documents, which are incorporated as part of this Contract:

- | | |
|--|--|
| Human Rights Division Contract
and Living Wage Declaration of
Compliance Forms (if applicable) | General Conditions
Standard Specifications
Detailed Specifications |
| Vendor Conflict of Interest Form | Plans |
| Bid Forms | Addenda |
| Contract and Exhibits | |
| Bonds | |

ARTICLE II - Definitions

Administering Service Area/Unit means Public Services Area/Water Treatment Services Unit

Project means Steere Farm Engine Replacement Project, ITB No. 4440

ARTICLE III - Time of Completion

- (A) The work to be completed under this Contract shall begin immediately on the date specified in the Notice to Proceed issued by the City.
- (B) The entire work for this Contract shall be completed within twenty-two (22) consecutive months.
- (C) Failure to complete all the work within the time specified above, including any extension granted in writing by the Supervising Professional, shall obligate the Contractor to pay the City, as liquidated damages and not as a penalty, an amount equal to \$500 for each calendar day of delay in the completion of all the work. If any liquidated damages are unpaid by the Contractor, the City shall be entitled to deduct these unpaid liquidated damages from the monies due the Contractor.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

Interim liquidated damages may apply as summarized in Section 01110 on the contract documents.

ARTICLE IV - The Contract Sum

- (A) The City shall pay to the Contractor for the performance of the Contract, the unit prices as given in the Bid Forms for the estimated bid total of:

_____ Dollars (\$_____)

- (B) The amount paid shall be equitably adjusted to cover changes in the work ordered by the Supervising Professional but not required by the Contract Documents. Increases or decreases shall be determined only by written agreement between the City and Contractor.

ARTICLE V - Assignment

This Contract may not be assigned or subcontracted any portion of any right or obligation under this contract without the written consent of the City. Notwithstanding any consent by the City to any assignment, Contractor shall at all times remain bound to all warranties, certifications, indemnifications, promises and performances, however described, as are required of it under this contract unless specifically released from the requirement, in writing, by the City.

ARTICLE VI - Choice of Law

This Contract shall be construed, governed, and enforced in accordance with the laws of the State of Michigan. By executing this agreement, the Contractor and the City agree to venue in a court of appropriate jurisdiction sitting within Washtenaw County for purposes of any action arising under this Contract. The parties stipulate that the venue referenced in this Contract is for convenience and waive any claim of non-convenience.

Whenever possible, each provision of the Contract will be interpreted in a manner as to be effective and valid under applicable law. The prohibition or invalidity, under applicable law, of any provision will not invalidate the remainder of the Contract.

ARTICLE VII - Relationship of the Parties

The parties of the Contract agree that it is not a Contract of employment but is a Contract to accomplish a specific result. Contractor is an independent Contractor performing services for the City. Nothing contained in this Contract shall be deemed to constitute any other relationship between the City and the Contractor.

Contractor certifies that it has no personal or financial interest in the project other than the compensation it is to receive under the Contract. Contractor certifies that it is not, and shall not become, overdue or in default to the City for any Contract, debt, or any other obligation to the City including real or personal property taxes. City shall have the right to set off any such debt against compensation awarded for services under this agreement.

ARTICLE VIII - Notice

All notices given under this Contract shall be in writing, and shall be by personal delivery or by certified mail with return receipt requested to the parties at their respective addresses as specified in the Contract Documents or other address the Contractor may specify in writing. Notice will be deemed given on the date when one of the following first occur: (1) the date of actual receipt, or (2) three days after mailing certified U.S. mail.

ARTICLE IX - Indemnification

To the fullest extent permitted by law, Contractor shall indemnify, defend and hold harmless the City, its officers, employees and agents harmless from all suits, claims, judgments and expenses including attorney’s fees resulting or alleged to result, in whole or in part, from any act or omission, which is in any way connected or associated with this Contract, by the Contractor or anyone acting on the Contractor’s behalf under this Contract. Contractor shall not be responsible to indemnify the City for losses or damages caused by or resulting from the City’s sole negligence. The provisions of this Article shall survive the expiration or earlier termination of this contract for any reason.

ARTICLE X - Entire Agreement

This Contract represents the entire understanding between the City and the Contractor and it supersedes all prior representations, negotiations, agreements, or understandings whether written or oral. Neither party has relied on any prior representations in entering into this Contract. No terms or conditions of either party’s invoice, purchase order or other administrative document shall modify the terms and conditions of this Contract, regardless of the other party’s failure to object to such form. This Contract shall be binding on and shall inure to the benefit of the parties to this Contract and their permitted successors and permitted assigns and nothing in this Contract, express or implied, is intended to or shall confer on any other person or entity any legal or equitable right, benefit, or remedy of any nature whatsoever under or by reason of this Contract. This Contract may be altered, amended or modified only by written amendment signed by the City and the Contractor.

FOR CONTRACTOR

By _____

Its: _____

FOR THE CITY OF ANN ARBOR

By _____
Christopher Taylor, Mayor

By _____
Jacqueline Beaudry, City Clerk

[signatures continue on next page]

Approved as to substance

By _____
Tom Crawford, City Administrator

By _____
Craig Hupy
Public Services Area Administrator

Approved as to form and content

Stephen K. Postema, City Attorney

PERFORMANCE BOND

- (1) _____ (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for \$ _____, the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.
- (2) The Principal has entered a written Contract with the City dated _____, 201_, for: _____ and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq.
- (3) Whenever the Principal is declared by the City to be in default under the Contract, the Surety may promptly remedy the default or shall promptly:
- (a) complete the Contract in accordance with its terms and conditions; or
 - (b) obtain a bid or bids for submission to the City for completing the Contract in accordance with its terms and conditions, and upon determination by Surety of the lowest responsible bidder, arrange for a Contract between such bidder and the City, and make available, as work progresses, sufficient funds to pay the cost of completion less the balance of the Contract price; but not exceeding, including other costs and damages for which Surety may be liable hereunder, the amount set forth in paragraph 1.
- (4) Surety shall have no obligation to the City if the Principal fully and promptly performs under the Contract.
- (5) Surety agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder, or the specifications accompanying it shall in any way affect its obligations on this bond, and waives notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work, or to the specifications.

SIGNED AND SEALED this _____ day of _____, 201_.

(Name of Surety Company)

By _____
(Signature)

Its _____
(Title of Office)

Approved as to form:

Stephen K. Postema, City Attorney

(Name of Principal)

By _____
(Signature)

Its _____
(Title of Office)

Name and address of agent:

LABOR AND MATERIAL BOND

- (1) _____
of _____(referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan, (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for the use and benefit of claimants as defined in Act 213 of Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq., in the amount of \$ _____, for the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.
- (2) The Principal has entered a written Contract with the City, dated _____, 2016, for _____; and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963 as amended;
- (3) If the Principal fails to promptly and fully repay claimants for labor and material reasonably required under the Contract, the Surety shall pay those claimants.
- (4) Surety's obligations shall not exceed the amount stated in paragraph 1, and Surety shall have no obligation if the Principal promptly and fully pays the claimants.

SIGNED AND SEALED this _____ day of _____, 2016.

(Name of Surety Company)

By _____
(Signature)

Its _____
(Title of Office)

Approved as to form:

Stephen K. Postema, City Attorney

(Name of Principal)

By _____
(Signature)

Its _____
(Title of Office)

Name and address of agent:

GENERAL CONDITIONS

Section 1 - Execution, Correlation and Intent of Documents

The contract documents shall be signed in 2 copies by the City and the Contractor.

The contract documents are complementary and what is called for by any one shall be binding. The intention of the documents is to include all labor and materials, equipment and transportation necessary for the proper execution of the work. Materials or work described in words which so applied have a well-known technical or trade meaning have the meaning of those recognized standards.

In case of a conflict among the contract documents listed below in any requirement(s), the requirement(s) of the document listed first shall prevail over any conflicting requirement(s) of a document listed later.

(1) Addenda in reverse chronological order; (2) Detailed Specifications; (3) Standard Specifications; (4) Plans; (5) General Conditions; (6) Contract; (7) Bid Forms; (8) Bond Forms; (9) Bid.

Section 2 - Order of Completion

The Contractor shall submit with each invoice, and at other times reasonably requested by the Supervising Professional, schedules showing the order in which the Contractor proposes to carry on the work. They shall include the dates at which the Contractor will start the several parts of the work, the estimated dates of completion of the several parts, and important milestones within the several parts.

Section 3 - Familiarity with Work

The Bidder or its representative shall make personal investigations of the site of the work and of existing structures and shall determine to its own satisfaction the conditions to be encountered, the nature of the ground, the difficulties involved, and all other factors affecting the work proposed under this Contract. The Bidder to whom this Contract is awarded will not be entitled to any additional compensation unless conditions are clearly different from those which could reasonably have been anticipated by a person making diligent and thorough investigation of the site.

The Bidder shall immediately notify the City upon discovery, and in every case prior to submitting its Bid, of every error or omission in the bidding documents that would be identified by a reasonably competent, diligent Bidder. In no case will a Bidder be allowed the benefit of extra compensation or time to complete the work under this Contract for extra expenses or time spent as a result of the error or omission.

Section 4 - Wage Requirements

Under this Contract, the Contractor shall conform to Chapter 14 of Title I of the Code of the City of Ann Arbor as amended; which in part states "...that all craftsmen, mechanics and laborers employed directly on the site in connection with said improvements, including said employees of subcontractors, shall receive the prevailing wage for the corresponding classes of craftsmen,

mechanics and laborers, as determined by statistics for the Ann Arbor area compiled by the United States Department of Labor. At the request of the City, any contractor or subcontractor shall provide satisfactory proof of compliance with the contract provisions required by the Section."

Where the Contract and the Ann Arbor City Ordinance are silent as to definitions of terms required in determining contract compliance with regard to prevailing wages, the definitions provided in the Davis-Bacon Act as amended (40 U.S.C. 278-a to 276-a-7) for the terms shall be used.

If the Contractor is a "covered employer" as defined in Chapter 23 of the Ann Arbor City Code, the Contractor agrees to comply with the living wage provisions of Chapter 23 of the Ann Arbor City Code. The Contractor agrees to pay those employees providing Services to the City under this Agreement a "living wage," as defined in Section 1:815 of the Ann Arbor City Code, as adjusted in accordance with Section 1:815(3); to post a notice approved by the City of the applicability of Chapter 23 in every location in which regular or contract employees providing services under this Agreement are working; to maintain records of compliance; if requested by the City, to provide documentation to verify compliance; to take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee or person contracted for employment in order to pay the living wage required by Section 1:815; and otherwise to comply with the requirements of Chapter 23.

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision covering subcontractor's employees who perform work on this contract.

Section 5 - Non-Discrimination

The Contractor agrees to comply, and to require its subcontractor(s) to comply, with the nondiscrimination provisions of MCL 37.2209. The Contractor further agrees to comply with the provisions of Section 9:158 of Chapter 112 of Title IX of the Ann Arbor City Code and to assure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity.

Section 6 - Materials, Appliances, Employees

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation, and other facilities necessary or used for the execution and completion of the work. Unless otherwise specified, all materials incorporated in the permanent work shall be new, and both workmanship and materials shall be of the highest quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

The Contractor shall at all times enforce strict discipline and good order among its employees, and shall seek to avoid employing on the work any unfit person or anyone not skilled in the work assigned.

Adequate sanitary facilities shall be provided by the Contractor.

Section 7 - Qualifications for Employment

The Contractor shall employ competent laborers and mechanics for the work under this Contract. For work performed under this Contract, employment preference shall be given to qualified local residents.

Section 8 - Royalties and Patents

The Contractor shall pay all royalties and license fees. It shall defend all suits or claims for infringements of any patent rights and shall hold the City harmless from loss on account of infringement except that the City shall be responsible for all infringement loss when a particular process or the product of a particular manufacturer or manufacturers is specified, unless the City has notified the Contractor prior to the signing of the Contract that the particular process or product is patented or is believed to be patented.

Section 9 - Permits and Regulations

The Contractor must secure and pay for all permits, permit or plan review fees and licenses necessary for the prosecution of the work. These include but are not limited to City building permits, right-of-way permits, lane closure permits, right-of-way occupancy permits, and the like. The City shall secure and pay for easements shown on the plans unless otherwise specified.

The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the contract documents are at variance with those requirements, it shall promptly notify the Supervising Professional in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the work.

Section 10 - Protection of the Public and of Work and Property

The Contractor is responsible for the means, methods, sequences, techniques and procedures of construction and safety programs associated with the work contemplated by this contract. The Contractor, its agents or sub-contractors, shall comply with the "General Rules and Regulations for the Construction Industry" as published by the Construction Safety Commission of the State of Michigan and to all other local, State and National laws, ordinances, rules and regulations pertaining to safety of persons and property.

The Contractor shall take all necessary and reasonable precautions to protect the safety of the public. It shall continuously maintain adequate protection of all work from damage, and shall take all necessary and reasonable precautions to adequately protect all public and private property from injury or loss arising in connection with this Contract. It shall make good any damage, injury or loss to its work and to public and private property resulting from lack of reasonable protective precautions, except as may be due to errors in the contract documents, or caused by agents or employees of the City. The Contractor shall obtain and maintain sufficient insurance to cover damage to any City property at the site by any cause.

In an emergency affecting the safety of life, or the work, or of adjoining property, the Contractor is, without special instructions or authorization from the Supervising Professional, permitted to act at its discretion to prevent the threatened loss or injury. It shall also so act, without appeal, if authorized or instructed by the Supervising Professional.

Any compensation claimed by the Contractor for emergency work shall be determined by agreement or in accordance with the terms of Claims for Extra Cost - Section 15.

Section 11 - Inspection of Work

The City shall provide sufficient competent personnel for the inspection of the work.

The Supervising Professional shall at all times have access to the work whenever it is in preparation or progress, and the Contractor shall provide proper facilities for access and for inspection.

If the specifications, the Supervising Professional's instructions, laws, ordinances, or any public authority require any work to be specially tested or approved, the Contractor shall give the Supervising Professional timely notice of its readiness for inspection, and if the inspection is by an authority other than the Supervising Professional, of the date fixed for the inspection. Inspections by the Supervising Professional shall be made promptly, and where practicable at the source of supply. If any work should be covered up without approval or consent of the Supervising Professional, it must, if required by the Supervising Professional, be uncovered for examination and properly restored at the Contractor's expense.

Re-examination of any work may be ordered by the Supervising Professional, and, if so ordered, the work must be uncovered by the Contractor. If the work is found to be in accordance with the contract documents, the City shall pay the cost of re-examination and replacement. If the work is not in accordance with the contract documents, the Contractor shall pay the cost.

Section 12 - Superintendence

The Contractor shall keep on the work site, during its progress, a competent superintendent and any necessary assistants, all satisfactory to the Supervising Professional. The superintendent will be responsible to perform all on-site project management for the Contractor. The superintendent shall be experienced in the work required for this Contract. The superintendent shall represent the Contractor and all direction given to the superintendent shall be binding as if given to the Contractor. Important directions shall immediately be confirmed in writing to the Contractor. Other directions will be confirmed on written request. The Contractor shall give efficient superintendence to the work, using its best skill and attention.

Section 13 - Changes in the Work

The City may make changes to the quantities of work within the general scope of the Contract at any time by a written order and without notice to the sureties. If the changes add to or deduct from the extent of the work, the Contract Sum shall be adjusted accordingly. All the changes shall be executed under the conditions of the original Contract except that any claim for extension of time caused by the change shall be adjusted at the time of ordering the change.

In giving instructions, the Supervising Professional shall have authority to make minor changes in the work not involving extra cost and not inconsistent with the purposes of the work, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Supervising Professional, and no claim for an addition to the Contract Sum shall be valid unless the additional work was ordered in writing.

The Contractor shall proceed with the work as changed and the value of the work shall be determined as provided in Claims for Extra Cost - Section 15.

Section 14 - Extension of Time

Extension of time stipulated in the Contract for completion of the work will be made if and as the Supervising Professional may deem proper under any of the following circumstances:

- (1) When work under an extra work order is added to the work under this Contract;

- (2) When the work is suspended as provided in Section 20;
- (3) When the work of the Contractor is delayed on account of conditions which could not have been foreseen, or which were beyond the control of the Contractor, and which were not the result of its fault or negligence;
- (4) Delays in the progress of the work caused by any act or neglect of the City or of its employees or by other Contractors employed by the City;
- (5) Delay due to an act of Government;
- (6) Delay by the Supervising Professional in the furnishing of plans and necessary information;
- (7) Other cause which in the opinion of the Supervising Professional entitles the Contractor to an extension of time.

The Contractor shall notify the Supervising Professional within 7 days of an occurrence or conditions which, in the Contractor's opinion, entitle it to an extension of time. The notice shall be in writing and submitted in ample time to permit full investigation and evaluation of the Contractor's claim. The Supervising Professional shall acknowledge receipt of the Contractor's notice within 7 days of its receipt. Failure to timely provide the written notice shall constitute a waiver by the Contractor of any claim.

In situations where an extension of time in contract completion is appropriate under this or any other section of the contract, the Contractor understands and agrees that the only available adjustment for events that cause any delays in contract completion shall be extension of the required time for contract completion and that there shall be no adjustments in the money due the Contractor on account of the delay.

Section 15 - Claims for Extra Cost

If the Contractor claims that any instructions by drawings or other media issued after the date of the Contract involved extra cost under this Contract, it shall give the Supervising Professional written notice within 7 days after the receipt of the instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property. The procedure shall then be as provided for Changes in the Work-Section I3. No claim shall be valid unless so made.

If the Supervising Professional orders, in writing, the performance of any work not covered by the contract documents, and for which no item of work is provided in the Contract, and for which no unit price or lump sum basis can be agreed upon, then the extra work shall be done on a Cost-Plus-Percentage basis of payment as follows:

- (1) The Contractor shall be reimbursed for all reasonable costs incurred in doing the work, and shall receive an additional payment of 15% of all the reasonable costs to cover both its indirect overhead costs and profit;
- (2) The term "Cost" shall cover all payroll charges for employees and supervision required under the specific order, together with all worker's compensation, Social Security, pension and retirement allowances and social insurance, or other regular payroll charges on same; the cost of all material and supplies required of either temporary or permanent character; rental of all power-driven equipment at agreed upon rates, together with cost of fuel and supply charges for the equipment; and any costs incurred by the Contractor as a direct result of executing the order, if approved by the Supervising Professional;

- (3) If the extra is performed under subcontract, the subcontractor shall be allowed to compute its charges as described above. The Contractor shall be permitted to add an additional charge of 5% percent to that of the subcontractor for the Contractor's supervision and contractual responsibility;
- (4) The quantities and items of work done each day shall be submitted to the Supervising Professional in a satisfactory form on the succeeding day, and shall be approved by the Supervising Professional and the Contractor or adjusted at once;
- (5) Payments of all charges for work under this Section in any one month shall be made along with normal progress payments. Retainage shall be in accordance with Progress Payments-Section 16.

No additional compensation will be provided for additional equipment, materials, personnel, overtime or special charges required to perform the work within the time requirements of the Contract.

When extra work is required and no suitable price for machinery and equipment can be determined in accordance with this Section, the hourly rate paid shall be 1/40 of the basic weekly rate listed in the Rental Rate Blue Book published by Dataquest Incorporated and applicable to the time period the equipment was first used for the extra work. The hourly rate will be deemed to include all costs of operation such as bucket or blade, fuel, maintenance, "regional factors", insurance, taxes, and the like, but not the costs of the operator.

Section 16 - Progress Payments

The Contractor shall submit each month, or at longer intervals, if it so desires, an invoice covering work performed for which it believes payment, under the Contract terms, is due. The submission shall be to the City's Finance Department - Accounting Division. The Supervising Professional will, within 10 days following submission of the invoice, prepare a certificate for payment for the work in an amount to be determined by the Supervising Professional as fairly representing the acceptable work performed during the period covered by the Contractor's invoice. To insure the proper performance of this Contract, the City will retain a percentage of the estimate in accordance with Act 524, Public Acts of 1980. The City will then, following the receipt of the Supervising Professional's Certificate, make payment to the Contractor as soon as feasible, which is anticipated will be within 15 days.

An allowance may be made in progress payments if substantial quantities of permanent material have been delivered to the site but not incorporated in the completed work if the Contractor, in the opinion of the Supervising Professional, is diligently pursuing the work under this Contract. Such materials shall be properly stored and adequately protected. Allowance in the estimate shall be at the invoice price value of the items. Notwithstanding any payment of any allowance, all risk of loss due to vandalism or any damages to the stored materials remains with the Contractor.

In the case of Contracts which include only the Furnishing and Delivering of Equipment, the payments shall be; 60% of the Contract Sum upon the delivery of all equipment to be furnished, or in the case of delivery of a usable portion of the equipment in advance of the total equipment delivery, 60% of the estimated value of the portion of the equipment may be paid upon its delivery in advance of the time of the remainder of the equipment to be furnished; 30% of the Contract Sum upon completion of erection of all equipment furnished, but not later than 60 days after the date of delivery of all of the equipment to be furnished; and payment of the final 10% on final completion of erection, testing and acceptance of all the equipment to be furnished; but not later

than 180 days after the date of delivery of all of the equipment to be furnished, unless testing has been completed and shows the equipment to be unacceptable.

With each invoice for periodic payment, the Contractor shall enclose a Contractor's Declaration - Section 43, and an updated project schedule per Order of Completion - Section 2.

Section 17 - Deductions for Uncorrected Work

If the Supervising Professional decides it is inexpedient to correct work that has been damaged or that was not done in accordance with the Contract, an equitable deduction from the Contract price shall be made.

Section 18 - Correction of Work Before Final Payment

The Contractor shall promptly remove from the premises all materials condemned by the Supervising Professional as failing to meet Contract requirements, whether incorporated in the work or not, and the Contractor shall promptly replace and re-execute the work in accordance with the Contract and without expense to the City and shall bear the expense of making good all work of other contractors destroyed or damaged by the removal or replacement.

If the Contractor does not remove the condemned work and materials within 10 days after written notice, the City may remove them and, if the removed material has value, may store the material at the expense of the Contractor. If the Contractor does not pay the expense of the removal within 10 days thereafter, the City may, upon 10 days written notice, sell the removed materials at auction or private sale and shall pay to the Contractor the net proceeds, after deducting all costs and expenses that should have been borne by the Contractor. If the removed material has no value, the Contractor must pay the City the expenses for disposal within 10 days of invoice for the disposal costs.

The inspection or lack of inspection of any material or work pertaining to this Contract shall not relieve the Contractor of its obligation to fulfill this Contract and defective work shall be made good. Unsuitable materials may be rejected by the Supervising Professional notwithstanding that the work and materials have been previously overlooked by the Supervising Professional and accepted or estimated for payment or paid for. If the work or any part shall be found defective at any time before the final acceptance of the whole work, the Contractor shall forthwith make good the defect in a manner satisfactory to the Supervising Professional. The judgment and the decision of the Supervising Professional as to whether the materials supplied and the work done under this Contract comply with the requirements of the Contract shall be conclusive and final.

Section 19 - Acceptance and Final Payment

Upon receipt of written notice that the work is ready for final inspection and acceptance, the Supervising Professional will promptly make the inspection. When the Supervising Professional finds the work acceptable under the Contract and the Contract fully performed, the Supervising Professional will promptly sign and issue a final certificate stating that the work required by this Contract has been completed and is accepted by the City under the terms and conditions of the Contract. The entire balance found to be due the Contractor, including the retained percentage, shall be paid to the Contractor by the City within 30 days after the date of the final certificate.

Before issuance of final certificates, the Contractor shall file with the City:

- (1) The consent of the surety to payment of the final estimate;
- (2) The Contractor's Affidavit in the form required by Section 44.

In case the Affidavit or consent is not furnished, the City may retain out of any amount due the Contractor, sums sufficient to cover all lienable claims.

The making and acceptance of the final payment shall constitute a waiver of all claims by the City except those arising from:

- (1) unsettled liens;
- (2) faulty work appearing within 12 months after final payment;
- (3) hidden defects in meeting the requirements of the plans and specifications;
- (4) manufacturer's guarantees.

It shall also constitute a waiver of all claims by the Contractor, except those previously made and still unsettled.

Section 20 - Suspension of Work

The City may at any time suspend the work, or any part by giving 5 days notice to the Contractor in writing. The work shall be resumed by the Contractor within 10 days after the date fixed in the written notice from the City to the Contractor to do so. The City shall reimburse the Contractor for expense incurred by the Contractor in connection with the work under this Contract as a result of the suspension.

If the work, or any part, shall be stopped by the notice in writing, and if the City does not give notice in writing to the Contractor to resume work at a date within 90 days of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work suspended and will be entitled to the estimates and payments for all work done on the portions abandoned, if any, plus 10% of the value of the work abandoned, to compensate for loss of overhead, plant expense, and anticipated profit.

Section 21 - Delays and the City's Right to Terminate Contract

If the Contractor refuses or fails to prosecute the work, or any separate part of it, with the diligence required to insure completion, ready for operation, within the allowable number of consecutive calendar days specified plus extensions, or fails to complete the work within the required time, the City may, by written notice to the Contractor, terminate its right to proceed with the work or any part of the work as to which there has been delay. After providing the notice the City may take over the work and prosecute it to completion, by contract or otherwise, and the Contractor and its sureties shall be liable to the City for any excess cost to the City. If the Contractor's right to proceed is terminated, the City may take possession of and utilize in completing the work, any materials, appliances and plant as may be on the site of the work and useful for completing the work. The right of the Contractor to proceed shall not be terminated or the Contractor charged with liquidated damages where an extension of time is granted under Extension of Time - Section 14.

If the Contractor is adjudged a bankrupt, or if it makes a general assignment for the benefit of creditors, or if a receiver is appointed on account of its insolvency, or if it persistently or repeatedly refuses or fails except in cases for which extension of time is provided, to supply enough properly skilled workers or proper materials, or if it fails to make prompt payments to subcontractors or for material or labor, or persistently disregards laws, ordinances or the instructions of the Supervising Professional, or otherwise is guilty of a substantial violation of any provision of the Contract, then the City, upon the certificate of the Supervising Professional that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Contractor 3 days written notice, terminate this Contract. The City may then take possession of the premises and of all materials, tools and appliances thereon and without prejudice to any other remedy it

may have, make good the deficiencies or finish the work by whatever method it may deem expedient, and deduct the cost from the payment due the Contractor. The Contractor shall not be entitled to receive any further payment until the work is finished. If the expense of finishing the work, including compensation for additional managerial and administrative services exceeds the unpaid balance of the Contract Sum, the Contractor and its surety are liable to the City for any excess cost incurred. The expense incurred by the City, and the damage incurred through the Contractor's default, shall be certified by the Supervising Professional.

Section 22 - Contractor's Right to Terminate Contract

If the work should be stopped under an order of any court, or other public authority, for a period of 3 months, through no act or fault of the Contractor or of anyone employed by it, then the Contractor may, upon 7 days written notice to the City, terminate this Contract and recover from the City payment for all acceptable work executed plus reasonable profit.

Section 23 - City's Right To Do Work

If the Contractor should neglect to prosecute the work properly or fail to perform any provision of this Contract, the City, 3 days after giving written notice to the Contractor and its surety may, without prejudice to any other remedy the City may have, make good the deficiencies and may deduct the cost from the payment due to the Contractor.

Section 24 - Removal of Equipment and Supplies

In case of termination of this Contract before completion, from any or no cause, the Contractor, if notified to do so by the City, shall promptly remove any part or all of its equipment and supplies from the property of the City, failing which the City shall have the right to remove the equipment and supplies at the expense of the Contractor.

The removed equipment and supplies may be stored by the City and, if all costs of removal and storage are not paid by the Contractor within 10 days of invoicing, the City upon 10 days written notice may sell the equipment and supplies at auction or private sale, and shall pay the Contractor the net proceeds after deducting all costs and expenses that should have been borne by the Contractor and after deducting all amounts claimed due by any lien holder of the equipment or supplies.

Section 25 - Responsibility for Work and Warranties

The Contractor assumes full responsibility for any and all materials and equipment used in the construction of the work and may not make claims against the City for damages to materials and equipment from any cause except negligence or willful act of the City. Until its final acceptance, the Contractor shall be responsible for damage to or destruction of the project (except for any part covered by Partial Completion and Acceptance - Section 26). The Contractor shall make good all work damaged or destroyed before acceptance. All risk of loss remains with the Contractor until final acceptance of the work (Section 19) or partial acceptance (Section 26). The Contractor is advised to investigate obtaining its own builders risk insurance.

The Contractor shall guarantee the quality of the work for a period of one year. The Contractor shall also unconditionally guarantee the quality of all equipment and materials that are furnished and installed under the contract for a period of one year. At the end of one year after the Contractor's receipt of final payment, the complete work, including equipment and materials furnished and installed under the contract, shall be inspected by the Contractor and the Supervising Professional. Any defects shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. Any defects that are identified prior to the end of

one year shall also be inspected by the Contractor and the Supervising Professional and shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. The Contractor shall assign all manufacturer or material supplier warranties to the City prior to final payment. The assignment shall not relieve the Contractor of its obligations under this paragraph to correct defects.

Section 26 - Partial Completion and Acceptance

If at any time prior to the issuance of the final certificate referred to in Acceptance and Final Payment - Section 19, any portion of the permanent construction has been satisfactorily completed, and if the Supervising Professional determines that portion of the permanent construction is not required for the operations of the Contractor but is needed by the City, the Supervising Professional shall issue to the Contractor a certificate of partial completion, and immediately the City may take over and use the portion of the permanent construction described in the certificate, and exclude the Contractor from that portion.

The issuance of a certificate of partial completion shall not constitute an extension of the Contractor's time to complete the portion of the permanent construction to which it relates if the Contractor has failed to complete it in accordance with the terms of this Contract. The issuance of the certificate shall not release the Contractor or its sureties from any obligations under this Contract including bonds.

If prior use increases the cost of, or delays the work, the Contractor shall be entitled to extra compensation, or extension of time, or both, as the Supervising Professional may determine.

Section 27 - Payments Withheld Prior to Final Acceptance of Work

The City may withhold or, on account of subsequently discovered evidence, nullify the whole or part of any certificate to the extent reasonably appropriate to protect the City from loss on account of:

- (1) Defective work not remedied;
- (2) Claims filed or reasonable evidence indicating probable filing of claims by other parties against the Contractor;
- (3) Failure of the Contractor to make payments properly to subcontractors or for material or labor;
- (4) Damage to another Contractor.

When the above grounds are removed or the Contractor provides a Surety Bond satisfactory to the City which will protect the City in the amount withheld, payment shall be made for amounts withheld under this section.

Section 28 - Contractor's Insurance

- (1) The Contractor shall procure and maintain during the life of this Contract, including the guarantee period and during any warranty work, such insurance policies, including those set forth below, as will protect itself and the City from all claims for bodily injuries, death or property damage which may arise under this Contract; whether the act(s) or omission(s) giving rise to the claim were made by the Contractor or by any subcontractor or anyone employed by them directly or indirectly. In the case of all contracts involving on-site work,

the Contractor shall provide to the City, before the commencement of any work under this contract, certificates of insurance and other documentation satisfactory to the City demonstrating it has obtained the policies and endorsements required on behalf of itself, and when requested, any subcontractor(s). The certificates of insurance endorsements and/or copies of policy language shall document that the Contractor satisfies the following minimum requirements.

- (a) Worker's Compensation Insurance in accordance with all applicable state and federal statutes. Further, Employers Liability Coverage shall be obtained in the following minimum amounts:

Bodily Injury by Accident - \$500,000 each accident
Bodily Injury by Disease - \$500,000 each employee
Bodily Injury by Disease - \$500,000 each policy limit

- (b) Commercial General Liability Insurance equivalent to, as a minimum, Insurance Services Office form CG 00 01 07 98 or current equivalent. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements specifically for the following coverages: Products and Completed Operations, Explosion, Collapse and Underground coverage or Pollution. Further there shall be no added exclusions or limiting endorsements which diminish the City's protections as an additional insured under the policy. The following minimum limits of liability are required:

\$1,000,000 Each occurrence as respect Bodily Injury Liability or Property
Damage Liability, or both combined.
\$2,000,000 Per Job General Aggregate
\$1,000,000 Personal and Advertising Injury
\$2,000,000 Products and Completed Operations Aggregate

- (c) Motor Vehicle Liability Insurance, including Michigan No-Fault Coverages, equivalent to, as a minimum, Insurance Services Office form CA 00 01 07 97 or current equivalent. Coverage shall include all owned vehicles, all non-owned vehicles and all hired vehicles. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements which diminish the City's protections as an additional insured under the policy. Further, the limits of liability shall be \$1,000,000 for each occurrence as respects Bodily Injury Liability or Property Damage Liability, or both combined.

- (d) Umbrella/Excess Liability Insurance shall be provided to apply excess of the Commercial General Liability, Employers Liability and the Motor Vehicle coverage enumerated above, for each occurrence and for aggregate in the amount of \$1,000,000.

- (2) Insurance required under subsection (1)(b) and (1)(c) above shall be considered primary as respects any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute with this insurance. Further, the Contractor agrees to waive any right of recovery by its insurer against the City.
- (3) Insurance companies and policy forms are subject to approval of the City Attorney, which approval shall not be unreasonably withheld. Documentation must provide and demonstrate an unconditional 30 day written notice of cancellation in favor of the City of Ann Arbor. Further, the documentation must explicitly state the following: (a) the policy

number; name of insurance company; name and address of the agent or authorized representative; name and address of insured; project name; policy expiration date; and specific coverage amounts; (b) any deductibles or self-insured retentions which shall be approved by the City, in its sole discretion; (c) that the policy conforms to the requirements specified. Contractor shall furnish the City with satisfactory certificates of insurance and endorsements prior to commencement of any work. Upon request, the Contractor shall provide within 30 days a copy of the policy(ies) to the City. If any of the above coverages expire by their terms during the term of this Contract, the Contractor shall deliver proof of renewal and/or new policies and endorsements to the Administering Service Area/Unit at least ten days prior to the expiration date.

- (4) Any Insurance provider of Contractor shall be admitted and authorized to do business in the State of Michigan and shall carry and maintain a minimum rating assigned by A.M. Best & Company's Key Rating Guide of "A-" Overall and a minimum Financial Size Category of "V". Insurance policies and certificates issued by non-admitted insurance companies are not acceptable unless approved in writing by the City.
- (5) City reserves the right to require additional coverage and/or coverage amounts as may be included from time to time in the Detailed Specifications for the Project.
- (6) The provisions of General Conditions 28 shall survive the expiration or earlier termination of this contract for any reason.
- (7) A template for the insurance an endorsement requirements is provided in the Appendices of this ITB.

Section 29 - Surety Bonds

Bonds will be required from the successful bidder as follows:

- (1) A Performance Bond to the City of Ann Arbor for the amount of the bid(s) accepted;
- (2) A Labor and Material Bond to the City of Ann Arbor for the amount of the bid(s) accepted.

Bonds shall be executed on forms supplied by the City in a manner and by a Surety Company authorized to transact business in Michigan and satisfactory to the City Attorney.

Section 30 - Damage Claims

The Contractor shall be held responsible for all damages to property of the City or others, caused by or resulting from the negligence of the Contractor, its employees, or agents during the progress of or connected with the prosecution of the work, whether within the limits of the work or elsewhere. The Contractor must restore all property injured including sidewalks, curbing, sodding, pipes, conduit, sewers or other public or private property to not less than its original condition with new work.

Section 31 - Refusal to Obey Instructions

If the Contractor refuses to obey the instructions of the Supervising Professional, the Supervising Professional shall withdraw inspection from the work, and no payments will be made for work performed thereafter nor may work be performed thereafter until the Supervising Professional shall have again authorized the work to proceed.

Section 32 - Assignment

Neither party to the Contract shall assign the Contract without the written consent of the other. The Contractor may assign any monies due to it to a third party acceptable to the City.

Section 33 - Rights of Various Interests

Whenever work being done by the City's forces or by other contractors is contiguous to work covered by this Contract, the respective rights of the various interests involved shall be established by the Supervising Professional, to secure the completion of the various portions of the work in general harmony.

The Contractor is responsible to coordinate all aspects of the work, including coordination of, and with, utility companies and other contractors whose work impacts this project.

Section 34 - Subcontracts

The Contractor shall not award any work to any subcontractor without prior written approval of the City. The approval will not be given until the Contractor submits to the City a written statement concerning the proposed award to the subcontractor. The statement shall contain all information the City may require.

The Contractor shall be as fully responsible to the City for the acts and omissions of its subcontractors, and of persons either directly or indirectly employed by them, as it is for the acts and omissions of persons directly employed by it.

The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractors to the Contractor by the terms of the General Conditions and all other contract documents applicable to the work of the subcontractors and to give the Contractor the same power to terminate any subcontract that the City may exercise over the Contractor under any provision of the contract documents.

Nothing contained in the contract documents shall create any contractual relation between any subcontractor and the City.

Section 35 - Supervising Professional's Status

The Supervising Professional has the right to inspect any or all work. The Supervising Professional has authority to stop the work whenever stoppage may be appropriate to insure the proper execution of the Contract. The Supervising Professional has the authority to reject all work and materials which do not conform to the Contract and to decide questions which arise in the execution of the work.

The Supervising Professional shall make all measurements and determinations of quantities. Those measurements and determinations are final and conclusive between the parties.

Section 36 - Supervising Professional's Decisions

The Supervising Professional shall, within a reasonable time after their presentation to the Supervising Professional, make decisions in writing on all claims of the City or the Contractor and on all other matters relating to the execution and progress of the work or the interpretation of the contract documents.

Section 37 - Storing Materials and Supplies

Materials and supplies may be stored at the site of the work at locations agreeable to the City unless specific exception is listed elsewhere in these documents. Ample way for foot traffic and drainage must be provided, and gutters must, at all times, be kept free from obstruction. Traffic on streets shall be interfered with as little as possible. The Contractor may not enter or occupy with agents, employees, tools, or material any private property without first obtaining written permission from its owner. A copy of the permission shall be furnished to the Supervising Professional.

Section 38 - Lands for Work

The Contractor shall provide, at its own expense and without liability to the City, any additional land and access that may be required for temporary construction facilities or for storage of materials.

Section 39 - Cleaning Up

The Contractor shall, as directed by the Supervising Professional, remove at its own expense from the City's property and from all public and private property all temporary structures, rubbish and waste materials resulting from its operations unless otherwise specifically approved, in writing, by the Supervising Professional.

Section 40 - Salvage

The Supervising Professional may designate for salvage any materials from existing structures or underground services. Materials so designated remain City property and shall be transported or stored at a location as the Supervising Professional may direct.

Section 41 - Night, Saturday or Sunday Work

No night or Sunday work (without prior written City approval) will be permitted except in the case of an emergency and then only to the extent absolutely necessary. The City may allow night work which, in the opinion of the Supervising Professional, can be satisfactorily performed at night. Night work is any work between 8:00 p.m. and 7:00 a.m. No Saturday work will be permitted unless the Contractor gives the Supervising Professional at least 48 hours but not more than 5 days notice of the Contractor's intention to work the upcoming Saturday.

Section 42 - Sales Taxes

Under State law the City is exempt from the assessment of State Sales Tax on its direct purchases. Contractors who acquire materials, equipment, supplies, etc. for incorporation in City projects are not likewise exempt. State Law shall prevail. The Bidder shall familiarize itself with the State Law and prepare its Bid accordingly. No extra payment will be allowed under this Contract for failure of the Contractor to make proper allowance in this bid for taxes it must pay.

Section 43

CONTRACTOR'S DECLARATION

I hereby declare that I have not, during the period _____, 20___, to _____, 20___, performed any work, furnished any materials, sustained any loss, damage or delay, or otherwise done anything in addition to the regular items (or executed change orders) set forth in the Contract titled _____, for which I shall ask, demand, sue for, or claim compensation or extension of time from the City, except as I hereby make claim for additional compensation or extension of time as set forth on the attached itemized statement. I further declare that I have paid all payroll obligations related to this Contract that have become due during the above period and that all invoices related to this Contract received more than 30 days prior to this declaration have been paid in full except as listed below.

There is/is not (Contractor please circle one and strike one as appropriate) an itemized statement attached regarding a request for additional compensation or extension of time.

Contractor

Date

By _____
(Signature)

Its _____
(Title of Office)

Past due invoices, if any, are listed below.

Section 44

CONTRACTOR'S AFFIDAVIT

The undersigned Contractor, _____, represents that on _____, 20__, it was awarded a contract by the City of Ann Arbor, Michigan to _____ under the terms and conditions of a Contract titled _____. The Contractor represents that all work has now been accomplished and the Contract is complete.

The Contractor warrants and certifies that all of its indebtedness arising by reason of the Contract has been fully paid or satisfactorily secured; and that all claims from subcontractors and others for labor and material used in accomplishing the project, as well as all other claims arising from the performance of the Contract, have been fully paid or satisfactorily settled. The Contractor agrees that, if any claim should hereafter arise, it shall assume responsibility for it immediately upon request to do so by the City of Ann Arbor.

The Contractor, for valuable consideration received, does further waive, release and relinquish any and all claims or right of lien which the Contractor now has or may acquire upon the subject premises for labor and material used in the project owned by the City of Ann Arbor.

This affidavit is freely and voluntarily given with full knowledge of the facts.

Contractor Date

By _____
(Signature)

Its _____
(Title of Office)

Subscribed and sworn to before me, on this ____ day of _____, 20__
_____, _____ County, Michigan

Notary Public
_____ County, MI

My commission expires on:

SUPPLEMENTAL GENERAL CONDITIONS

General Safety Requirements

The Contractor shall be responsible for ensuring compliance with the most stringent provisions of the applicable statutes and regulations of the Michigan Occupational Safety and Health Act 154 of 1974, the Occupational Safety and Health Act of 1970, and all City of Ann Arbor safety policies. The Contractor shall flow down all these requirements to any subcontractor performing work under the contract. Should charges of violation of any of the above be issued to the Contractor in the course of the work, a copy of each charge shall be immediately forwarded to the City along with a plan to correct the violation.

Upon the failure of the Contractor to comply with any of these requirements, the City's Representative shall have the authority to stop any and all operations of the Contractor affected by such failure until such failure is remedied. No part of the time lost due to any such stop orders shall be made subject to a claim or extension of time or increase in compensation.

All materials, equipment, and supplies provided to the City of Ann Arbor must comply fully with all safety requirements as set forth by the Michigan Occupational Safety and Health Act 154 of 1974 and all applicable OSHA Standards.

STANDARD SPECIFICATIONS

All work under this contract shall be performed in accordance with the Public Services Department Standard Specifications in effect at the date of availability of the contract documents stipulated in the Bid. All work under this Contract which is not included in these Standard Specifications, or which is performed using modifications to these Standard Specifications, shall be performed in accordance with the Detailed Specifications included in these contract documents.

Standard Specifications are available online:

<http://www.a2gov.org/departments/engineering/Pages/Engineering-and-Contractor-Resources.aspx>

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DETAILED SPECIFICATION

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SECTION 01110 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. The Project is located at the City of Ann Arbor's Steere Farm Well Field located at the Ann Arbor Municipal Airport (4350 S. State Street) within Pittsfield Township, Michigan.
- B. The Work consists of removal of the existing natural gas driven engines on well pumps located in Well House 25W, 21W and 741 with electric motors and natural gas back-up generator system. A new duct bank for the electrical supply will be constructed. The work also includes electrical, mechanical and architectural improvements to the well house buildings.

1.02 WORK SEQUENCE

- A. CONTRACTOR shall arrange its Work so that at no time shall it cause unnecessary interruption to the operation of existing facilities. CONTRACTOR shall prepare and submit to ENGINEER for approval, a complete detailed working schedule in compliance with the OWNER's schedule, setting forth the sequence of operations CONTRACTOR proposes to follow. No work shall commence until the OWNER/ENGINEER has approved this plan.
- B. The City of Ann Arbor requires two well pumps to be operational at all times either from the existing natural gas engines or the proposed electrical motor.
- C. As a guide in preparing a construction sequence for the project, the CONTRACTOR shall use the following:
 - 1. Suggested General Sequence
 - a. Submit Project Schedule and CONTRACTOR's Proposed Protection of Process Water plan for review and approval.
 - b. Perform walk-through of site with ENGINEER.
 - c. Apply for all permits
 - d. Coordinate with Detroit Edison (allowance work) for extension of overhead, high-voltage, electrical service along State Road to beginning of duct bank.
 - e. Construct electrical supply improvements and building repairs. Install generator. Provide notice prior to beginning work at each well house to allow water treatment services unit staff to isolate the pump. Coordinate with Detroit Edison for installation of electrical service.
 - f. Remove existing natural gas engines in Well House 25W while allowing the City to operate the engine in the other two well houses.
 - g. Complete building improvements and start-up motors/generator in Well House 25W and demonstrate satisfactory system operation in this well house.
 - h. Perform commissioning and training of City staff.
 - i. Remove existing natural gas engine in Well House 21W.
 - j. Start-up motor and electrical service in Well House 21W.
 - k. Perform commissioning and demonstration in Well House 21 W.
 - l. Remove existing natural gas engine in Well House 741.
 - m. Start-up motor and electrical service in Well House 741.
 - n. Perform commissioning and demonstration in Well House 741.
 - o. Restore the project site.

2. Schedule

- a. The duration set in article III of the contract is fixed and non-negotiable.
- b. Contractor shall be responsible for providing additional crews as required at no additional cost to the OWNER to meet the schedule.
- c. The OWNER shall have the authority to order work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary supply of water. The OWNER reserves the right to cancel a scheduled shutdown, without additional compensation due the CONTRACTOR, and will consider a contract extension if the cancellation affects the CONTRACTOR's critical path.
- d. If the CONTRACTOR impairs performance or operation of the system as to result in discontinuation of the water supply, then the CONTRACTOR shall immediately make all repairs or replacements and do the work necessary to restore the system to operation to the satisfaction of the OWNER and ENGINEER. Such work shall progress continuously to completion 24 hours per day and seven days per week.
- e. After any damage to the existing facilities by the CONTRACTOR's work that, in the opinion of the OWNER, constitutes an emergency, the CONTRACTOR shall be immediately available and provide immediate services for the repair and mitigation of the emergency.
- f. Shutdowns shall be scheduled between Monday and Friday unless there are extenuating circumstances approved by the OWNER and ENGINEER.
- g. The Contractor will not disturb the maintenance of water supply operations without a written and approved plan.
- h. The Contractor will submit plans for approval for any needed outages or disturbances to operations. These plans will include the area, process or systems that will be impacted and duration of the outage. No plans can be implemented without written authorization from OWNER and ENGINEER.

1.03 SUBSTANTIAL COMPLETION

- A. The project shall be substantially complete when all three well houses have been rehabilitated and the motors, pumps, and generators in each of the three well houses are fully operational and have been started-up in accordance with these specifications. This milestone will also consist of acceptance of O&M documents and operational demonstration. Refer to section 01770 for additional requirements of substantial completion.

1.04 LIQUIDATED DAMAGES

- A. Liquidated damages will be applied independently for each area of improvements that are not completed by the dates set by this Contract.
- B. Where the schedule requirements identified in the this Section are not met; including repairs not fully complete, final cleaning, equipment reinstallation and all other work to make the structure suitable for Owner operation, non-quantifiable liquidated damages in the following amounts will be applied.

Key Contract Dates:

<u>Milestone</u>	<u>Completion Date</u>	<u>Liquidated Damages</u>
Substantial Completion	20 months	\$500/day
Final Completion	22 months	\$500/day

Interim Dates:

The well houses shall not be out of service longer than the durations specified below.

<u>Constraint</u>	<u>Duration</u>	<u>Liquidated Damage</u>
Well House 25W Out of Service	8 months	\$500/day
Well House 21W Out of Service	4 months	\$500/day
Well House 741 Out of Service	4 months	\$500/day

1.05 CONTRACTOR USE OF PREMISES

- A. Limit use of the premises to construction activities in areas indicated; allow for OWNER occupancy. Confine operations to areas within Contract limits indicated. Portions of the Site beyond areas in which construction operations are indicated are not to be disturbed.
- B. Keep driveways and entrances serving the premises clear and available to OWNER, OWNER's employees, and other users at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on Site. Areas for CONTRACTOR's trailers, equipment, and material storage, and CONTRACTOR's employee parking shall be as indicated on Drawings or agreed by OWNER prior to the start of construction.
- C. The CONTRACTOR shall maintain the site and surrounding public properties free from accumulations of waste, debris and rubbish, caused by the construction operations.
- D. CONTRACTOR use of OWNER's utilities (power and water) is covered in Section 01500. CONTRACTOR shall coordinate all connections and usage of OWNER utilities to ensure no disruption with normal plant operation.
- E. CONTRACTOR shall provide his own restroom facilities, see Section 01500.

1.06 OWNER OCCUPANCY

- A. OWNER Occupancy: OWNER may occupy the Site and existing buildings during the entire construction period. Cooperate with OWNER during construction operations to minimize conflicts and facilitate OWNER usage. Perform the Work so as not to interfere with OWNER's operations. Adequate parking for OWNER staff shall be maintained at all times.
- B. OWNER reserves the right to occupy and to place and install equipment in completed areas of the building, prior to Substantial Completion provided that such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.

- C. Obtain a Certificate of Occupancy from local building officials prior to OWNER occupancy.
- D. Prior to partial OWNER occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, OWNER will provide operation and maintenance of mechanical and electrical systems in occupied portions of the building.

1.07 MISCELLANEOUS PROVISIONS

- A. CONTRACTOR shall notify all Owners of public utilities within the right-of-way or easement for the purpose of establishing the approximate locations of the utilities in accordance with the requirements of Act No. 53 Public Acts of 1974 of the State of Michigan. CONTRACTOR shall notify MISS DIG-Utility Communication System, 1-800-482-7171, three working days prior to starting any excavation with power equipment.
- B. CONTRACTOR shall be responsible for verifying the location of all underground utilities by magnetic or other type instruments before beginning excavation Work.
- C. Natural Gas Service
 - a. The existing 3-inch high pressure natural gas service may need to be relocated outside of the influence of construction and a higher capacity gas meter must be installed. The relocation must occur prior to all other utility work within the vicinity of the gas service.
 - b. Contractor shall coordinate the gas service relocation with DTE Energy. Payment for the relocation of the gas service shall be paid for under the natural gas allowance.
 - c. The gas shutdown for the service relocation and meter replacement shall last no more than 24 hours. The connection shall be scheduled within the OWNER. CONTRACTOR shall provide at least 14-day notice of when the gas main shutdown will occur.
 - d. Contractor shall backfill the work with compacted sand and restore the surface with grass.
- D. Time and Sequence of Work: In general, it is the intention and understanding that CONTRACTOR shall have control over the sequence or order of execution of the several parts of the Work to be done under the Contract and over the method of accomplishing the required results, except as some particular sequence or method may be distinctly demanded by the Drawings and Project Manual or by the expressed provisions of the Contract. ENGINEER may, however, make such reasonable requirements as may, in ENGINEER's judgment, be necessary for the proper and effective protection of Work partially or wholly completed, and to these requirements CONTRACTOR shall conform.
- E. Well Disinfection: Prior to recommissioning wells after installation of power, CONTRACTOR shall disinfect wells, flush wells and collect samples to verify the wells are free from bacteria. All City testing and sampling procedures shall be followed. CONTRACTOR may deliver samples to Ann Arbor Water Treatment Plant for analysis.

1.08 PROTECTION OF WORK AND MATERIAL

- A. During the progress of the work and up to the date of final payment, the CONTRACTOR shall be solely responsible for the care and protection of all work and materials covered by the Contract, except where a certificate of partial substantial completion has been issued by the OWNER.

- B. All work and materials shall be protected against damage, injury or loss from any cause whatsoever, and the CONTRACTOR shall make good any such damage of loss at his own expense. Protection measures shall be subject to the approval of the OWNER.

1.09 SECURITY AND ACCESS

- A. The City of Ann Arbor airport is a secure area. The CONTRACTOR must comply with the City's security requirements including, but not limited to:
 - 1. Proper identification of employees
 - 2. Provide and use photo IDs for all CONTRACTOR personnel
 - 3. Maintain daily sign-in log of personnel and visitors
 - 4. Provide a list of personnel and vehicles on site
 - 5. Maintain a daily log of vehicle license plate numbers on site
 - 6. Allow OWNER to conduct background checks on CONTRACTOR's personnel upon request
 - 7. Supplying a project lock for access to site
 - 8. Notify City in advance of material deliveries to site, including delivery contents

These provisions may be modified by the City at any time.

- B. Use of OWNER's security measures does not relieve Contractor of its responsibility to secure its own working spaces and materials.
- C. Access to Site, Roadways, and Parking Areas
 - 1. The CONTRACTOR shall be responsible for providing access to the construction area and for preparing and maintaining temporary access road, fence, and/or gate, as needed. It shall be the responsibility of the CONTRACTOR to obtain any permits required from the City of Ann Arbor or Pittsfield Township and pay all associated fees.
 - 2. The CONTRACTOR shall be responsible for removal of snow in areas of the CONTRACTOR's work.
 - 3. CONTRACTOR shall repair the access road upon conclusion of the project.

1.10 GUARANTEE

- A. The CONTRACTOR shall be present for a site inspection before the warranty expires. At this time, the OWNER will develop a punch list of deficiencies to be addressed by the CONTRACTOR. The CONTRACTOR shall address these items within 14 days of the inspection.

1.11 PERMITS

- A. The CONTRACTOR will be required to follow the requirements established by all permits necessary for the construction of this project. The following is a list of all permits that must be obtained prior to the beginning of construction.
 - 1. Pittsfield Township Building Permit (including all applicable trades)
 - 2. MDEQ Part 399 Permit Application for Water Supply Systems
 - 3. Washtenaw County Soil Erosion Control Permit (if needed) and Drain Crossing Permit
 - 4. Federal Aviation Administration
- B. The Building permit shall be applied for by the CONTRACTOR. The plan review fee shall be paid for by the CONTRACTOR. The CONTRACTOR shall be required to obtain the permit, pay all associated fees and adhere to all requirements of the permit. The CONTRACTOR must submit a copy of the permit to the OWNER and ENGINEER prior to construction.

- C. CONTRACTOR may be required to obtain a permit from the City of Ann Arbor or the Washtenaw County Road Commission should any part of project mobilization or project activities interfere with traffic on a City street or county road.
- D. The MDEQ Permit shall be applied for by the ENGINEER. All requirements set by this permit shall be followed by the CONTRACTOR.
- E. The Soil Erosion Control Permit shall be applied for by the Contractor. The CONTRACTOR shall be required to obtain the permit, pay all associated fees and adhere to all requirements of the permit.

1.12 RESTORATION OF DISTURBED LAWN AREAS

- A. Recondition existing lawn areas damaged by CONTRACTOR's operations including storage of materials and equipment and movement of vehicles.
- B. All lawn areas shall be restored to a condition that is equal to or better than prior to construction.
- C. Construction methods for seeding and mulching shall be in accordance with the City of Ann Arbor Public Services Department Standard Specifications, Division VIII – Landscaping and Restoration.
- D. Seeding dates, kinds of seed and rates shall be as follows:
 - April 15 – October 10
 - Perennial Ryegrass (44 lb/acre)
 - Kentucky Bluegrass (66 lb/acre) and
 - Creeping Red Fescue (110 lb/acre)
- E. Contractor's obligation for lawn restoration shall not be relieved until the grass seed has germinated and covered the disturbed area to a density similar to surrounding, undisturbed areas.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 CONTROL OF WATER POLLUTION

- A. General Requirements
 - 1. The CONTRACTOR shall conduct his work in such manner as to prevent the entry of fuels, oils, bituminous materials, chemical, sewage or other harmful materials into the City's water supply or on to the soil.
 - 2. The CONTRACTOR shall take all necessary precautions to prevent the entry of these harmful materials including the use of tarps, planks, protective trusses or scaffolding systems, or other OWNER and ENGINEER approved methods.
 - 3. Any vehicles or equipment with oil, fuel, or other fluid leaks shall not be allowed on the site and shall be immediately removed upon detection.

B. Penalties

1. The CONTRACTOR shall be responsible for any remedial costs resulting from the pollution of the ground or groundwater resulting from CONTRACTOR's actions or the work under the CONTRACTOR's control. The City may elect to perform remedial measures and without the costs of these measures from payment due the CONTRACTOR.

END OF SECTION

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SECTION 01210 - ALLOWANCES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for processing Allowances. Selected materials and equipment, and in some cases their installation, are shown and specified in the Contract Documents by Allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. Additional requirements, if necessary, will be issued by Change Order.

1.02 DEFINITIONS

- A. Lump Sum Allowance: A monetary sum that includes, as part of the Contract Price, the associated costs and requirements to complete the specified Allowance.

1.03 SUBMITTALS

- A. Submit invoices or delivery slips to indicate actual quantities of materials delivered to the Site for use in fulfillment of each Allowance.

1.04 OWNER'S INSTRUCTIONS

- A. At the earliest feasible date after Contract Award, advise ENGINEER of the date when the final selection and purchase of each product or system described by an Allowance must be completed in order to avoid delay in performance of the Work.
- B. When requested by ENGINEER, obtain Bids for each Allowance for use in making final selections; include recommendations that are relevant to performance of the Work.
- C. Purchase products and systems as selected by ENGINEER from the designated supplier.
- D. Use Allowances only as directed for OWNER's purposes, and only by Change Orders which designate amounts to be charged to the Allowance.
- E. If the actual price for the specified Allowance is more or less than the stated Allowance, the Contract Price shall be adjusted accordingly by Change Order. The adjustment in Contract Price shall be made in accordance with Paragraph 11.02 of the General Conditions.
- F. Change Orders authorizing use of funds from the Contingency or Provisionary Allowances will include CONTRACTOR's related costs and reasonable overhead and profit margins pursuant to the General Conditions.
- G. At Project closeout, any amounts remaining in Allowances will be credited to OWNER by Change Order.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect products covered by an Allowance promptly upon delivery for damage or defects.

3.02 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related construction activities.

SCHEDULE OF ALLOWANCES

- 1. Lump Sum Allowance for Electrical Service. The Utility Company (DTE Energy) will furnish and install an electrical service as shown on Drawings. Equipment and Work to be included in the allowance shall include the following:
 - a. Overhead Line extension (including poles) from power pole near hangers, south along State Street to drop pole shown on plans.

An allowance of \$70,000 shall be included in the Contract Price for this Work. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract. The allowance shall not include the service switch or other equipment and materials beyond the service switch unless indicated otherwise. Site preparation work for the utility service shown shall be paid for under Division 2 of this Contract and is not part of this allowance. For further information, contact:

Name Jacob Geiger
Company Detroit Edison
Address 414 S. Main Street, #600
Phone (734) 302-4800

- 2. Lump Sum Allowance for Permits. An allowance of \$20,000 shall be included in the Contract Price for this Work. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract. For further information, contact:

Company Pittsfield Township
Address 6201 W. Michigan Avenue
 Ann Arbor, MI 48108
Phone (734) 822-3101

Company Washtenaw County
Address 705 N. Zeeb Road
 Ann Arbor, MI 48103
Phone (734) 222-6860

- 3. Lump Sum Allowance for Relocation of Natural Gas Line. An existing natural gas pipe near well house 25W may be relocated and service to the affected parties provided for in another manner by DTE Energy. An allowance of \$40,000 shall be included in the Contract Price for this Work. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract. For further information, contact:

Name Jacob Geiger
Company Detroit Edison
Address 414 S. Main Street, #600
Phone (734) 302-4800

END OF SECTION

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SECTION 01230 - ALTERNATES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for Alternates.

1.02 DEFINITIONS

- A. Alternate: An amount proposed by Bidders and stated on Bid Form for certain construction activities defined in the Bidding Requirements that may be added to or deducted from Base Bid amount if OWNER decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1.03 OWNER'S INSTRUCTIONS

- A. Coordinate related Work and modify or adjust adjacent Work as necessary to ensure that Work affected by each accepted Alternate is complete and fully integrated into the Project.
- B. OWNER will evaluate Bids from the Base Lump Sum Bid price, and add or deduct the amounts stated on Bid Form for the Alternate in the order in which the Alternates are listed on Schedule at the end of this Section. OWNER reserves the right to determine how many Alternates will be added or deducted for this Project. The cost of the Alternate shall include any appropriate amounts for general conditions, bonds, insurances, materials, labor, tools, power, transportation, construction equipment, and associated items involved with the described Alternate.
- C. Immediately following the award of the Contract, prepare and distribute to each party involved, notification of the status of each Alternate. Indicate whether Alternates have been accepted, rejected, or deferred for consideration at a later date. Include a complete description of negotiated modifications to Alternates.
- D. A "Schedule of Alternates" is included at the end of this section and on the Bid Form contain requirements for materials and methods necessary to achieve the Work described under each Alternate. Additional information may be available in the drawings and specifications.
- E. Include as part of each Alternate, miscellaneous devices, accessory objects, and similar items that are included with or required for a complete installation, whether or not mentioned as part of the Alternate.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

SCHEDULE OF ALTERNATES

Alternates to the Base Bid Form are offered as follows:

Alternate No. 1

Description: Provide Kohler Generator in lieu of Cummins Generator

Reference Specification Section 16231.

Alternate No. 2

Description: Salvage the three existing Caterpillar engines by placing them at a mutually agreeable location on the project site for later disposal by the City of Ann Arbor

Alternate No. 3

Description: In lieu of installing masonry knee wall on each well house, install continuous insulated metal siding. This alternative is inclusive of work at all three well houses.

Alternate No. 4

Description: Eliminate epoxy coating on floor surfaces and install concrete sealer per paint spec 09900.

Alternate No. 5

Description: For buildings 21W and 741, eliminate trench drains, sump, sump pumps, and concrete slab replacement required for trench drain and sump installation.

Alternate No 6

Description: For buildings 25W and 21W, to provide service to hose bibbs, eliminate tap on 12" main downstream of check valve and instead connect to main upstream of the check valve.

Alternate No. 7

Description: Provide manufacturers Remote Training Class on VFDs and generator (two classes).

Alternate No. 8

Description: Facility online training per spec section 01830.

END OF SECTION

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SECTION 01270 - MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: This Section specifies administrative and procedural requirements for measurement and payment. Payment for Work under this Contract will be made on a unit price or lump sum basis for Work actually completed. Final measurements of the Work will be taken by ENGINEER to determine the amount of Work completed. The method of applying the unit prices to measured quantities shall be as specified in this Section.

1.02 OWNER'S INSTRUCTIONS

- A. Payment will only be made for items listed on Bid Form. The costs for other Work required for a complete Project will be included in the prices Bid for the other items of Work listed on Bid Form.
- B. Payment for each item will be in accordance with Paragraph 11.03 of the General Conditions, and include all applicable labor, material, equipment, and ancillary items to complete the Work specified.
- C. All measurements shall be rounded to the nearest whole unit.
- D. Restoration Costs: Where payment for surface restoration is included in the unit prices for underground utilities, 20 percent of the unit price for the utility will be withheld until surface restoration has been completed. Restoration in this context includes surface grading, placement of topsoil, seed, fertilizer and mulch, and all clean up necessary for the Work. When ENGINEER determines that the restoration Work has been completed satisfactorily, the 20 percent will be authorized for the next partial pay estimate.

1.03 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by ENGINEER and paid for by OWNER.
- B. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
- C. The date for each progress payment will be determined at the Pre-Construction Conference. The period of construction Work covered by each Application for Payment is 1 month. Actual start/end dates will be determined at the Pre-Construction Conference.
- D. Use the AIA (American Institute of Architects) Application and Certification for Payment form for Applications for Payment.
 - 1. Complete every entry on the form, including execution by person authorized to sign legal documents on behalf of CONTRACTOR.
 - 2. Incomplete applications will be returned without action.

- E. Initial Application for Payment: Administrative actions and submittals that must precede submittal of the first Application for Payment include the following:
 - 1. List of subcontractors.
 - 2. List of principal suppliers and fabricators.
 - 3. CONTRACTOR's Construction Schedule (preliminary if not final).
 - 4. Schedule of principal products.
 - 5. Submittal Schedule (preliminary if not final).

- F. Application for Payment at Substantial Completion: Administrative actions and submittals that shall proceed or coincide with this application include:
 - 1. Warranties (guarantees) and maintenance agreements.
 - 2. Maintenance instructions.
 - 3. Meter readings.
 - 4. Start-up performance reports.
 - 5. Changeover information related to OWNER's occupancy, use, operation, and maintenance.
 - 6. Final cleaning.
 - 7. Application for reduction of retainage, and consent of surety.
 - 8. Advice on shifting insurance coverages.
 - 9. Final progress photographs.
 - 10. List of incomplete Work, recognized as exceptions to ENGINEER's Certificate of Substantial Completion.

- G. Final Payment Application: Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
 - 1. Completion of Project closeout requirements.
 - 2. Completion of items specified for completion after Substantial Completion.
 - 3. Assurance that unsettled claims will be settled.
 - 4. Assurance that Work not complete and accepted will be completed without undue delay.
 - 5. Transmittal of required Project construction records to OWNER.
 - 6. Proof that taxes, fees, and similar obligations have been paid.
 - 7. Removal of temporary facilities and services.
 - 8. Removal of surplus materials, rubbish, and similar elements.
 - 9. CONTRACTOR's waivers of mechanics liens for Project.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

SCHEDULE OF UNIT PRICES

Description: Allowances
Payment: Lump Sum.
Measurement: Each.
Work Required: As specified in Section 01210 - Allowances.

Description: Mobilization
Payment: Lump Sum. This unit price will be limited to no more than 2% of the total bid. 50 percent of unit price amount will be paid when Work has begun, 50 percent paid when Work is complete and Site fully restored.
Measurement: Each.
Work Required: For Mobilization: Transporting equipment to Site, CONTRACTOR's bonds and insurance, site condition documentation, and any other temporary facilities required.
For Demobilization: Removal of equipment from Site, removal of temporary facilities, and completion of all restoration.

Description: Well Houses 21W, 25W, 741 and All Related Work
Payment: Lump Sum.
Measurement: Each.
Work Required: Removal of existing natural gas driven engines, including concrete base, installation of new electric pump motors, generators, associated electrical equipment, survey layout, excavation, site preparation, duct bank construction, removal and replacement of Well Houses No. 25W, 21W and 741, pavement gravel, site restoration, access drive repair, pipe painting, project sign, temporary facilities and all other work as shown on Contract Drawings and as specified.

Description: Start-up, Commissioning and Training
Payment: Lump Sum.
Measurement: Each.
Work Required: Testing, start-up and commissioning of all mechanical, electrical and instrumentation systems, any specified training and coordination with City and other related work.

Description: Final Closeout
Payment: Lump Sum.
Measurement: Each.
Work Required: Submission of O&M documents, submission of record drawings, work outlined in specification 01770 and all other work associated with closing out contract items.

END OF SECTION

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SECTION 01290 - APPLICATIONS FOR PAYMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements governing CONTRACTOR's Applications for Payment.
- B. Related Sections:
 - 1. CONTRACTOR's Construction Schedule and Submittal Schedule are included in Section 01330.

1.02 OWNER'S INSTRUCTIONS

- A. Schedule of Values:
 - 1. Coordinate preparation of Schedule of Values with preparation of CONTRACTOR's Construction Schedule.
 - 2. Correlate line items on Schedule of Values with other required administrative schedules and forms, including:
 - a. CONTRACTOR's Construction Schedule.
 - b. Application for Payment form.
 - c. List of subcontractors.
 - d. Schedule of Allowances.
 - e. Schedule of Alternates.
 - f. List of products.
 - g. List of principal suppliers and fabricators.
 - h. Schedule of Submittals.
 - 3. Submit Schedule of Values to ENGINEER at the earliest feasible date, but in no case later than 7 days before the date scheduled for submittal of the initial Application for Payment.
 - 4. Format and Content: Use the Project Manual Table of Contents as a guide to establish the format for Schedule of Values.
 - 5. Identification: Include the following Project identification on Schedule of Values:
 - a. Project name and location.
 - b. Name of ENGINEER.
 - c. Project number.
 - d. CONTRACTOR's name and address.
 - e. Date of submittal.
 - 6. Arrange Schedule of Values in a tabular form with separate rows for each Specification Section and separate columns for each major structure or area of Work.
 - 7. Provide a breakdown of the Contract Price in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Break principal subcontract amounts down into several line items.
 - 8. Round off amounts to the nearest whole dollar; the total shall equal the Contract Price.
 - 9. For each part of the Work where an Application for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed, provide separate line items on Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

10. Show line items for indirect costs, and margins on actual costs, only to the extent that such items will be listed individually on Applications for Payment. Each item on Schedule of Values and Applications for Payment shall be complete including its total cost and proportionate share of general overhead and profit margin.
 11. At CONTRACTOR's option, temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown as separate line items on Schedule of Values or distributed as general overhead expense.
 12. Update and resubmit Schedule of Values when Change Orders or Work Change Directives result in a change in the Contract Price.
 13. A Lump Sum payment equal to 1-1/2% of the total Bid Price (to include all bonds, insurance, etc.) will be allowed for "mobilization" as a progress payment line item. The actual cost of bonds and insurance (up to maximum payment of 1-1/2%) will be considered in the initial payment request provided that cost documentation suitable to the OWNER is furnished by the CONTRACTOR. Any outstanding balance of the mobilization line item will be payable when the Project work is 10% complete as indicated by the approved progress payments (less costs of mobilization and stored equipment).
 14. Payment Restrictions
 - a. Major equipment items will be paid according to the following schedule:
 - 1) Upon equipment delivery – 60% of the contract amount
 - 2) Upon successful start-up, testing and validation (i.e. substantial completion) – 30% of the contract amount
 - 3) Upon completion of punch list work (i.e. final completion) – 10% of the contract amount
 - b. Retainage shall apply to the above payment sequence
 - c. Major equipment items are considered to consist of the following items:
 - 1) Electric motors
 - 2) Generator
 - 3) VFDs
 - 4) Motor control centers
- B. Initial Application for Payment: Administrative actions and submittals that must precede submittal of the first Application for Payment include the following:
1. List of subcontractors.
 2. List of principal suppliers and fabricators.
 3. Schedule of Values.
 4. CONTRACTOR's Construction Schedule (preliminary if not final).
 5. Schedule of principal products.
 6. Submittal Schedule (preliminary if not final).
- C. Applications For Payment:
1. Each Application for Payment shall be consistent with previous applications and payments as certified by ENGINEER and paid for by OWNER.
 2. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
 3. The date for each progress payment will be determined at the Pre-Construction Conference. The period of construction Work covered by each Application for Payment is 1 month. Actual start/end dates will be determined at the Pre-Construction Conference.
 4. Complete every entry on the form, including execution by person authorized to sign legal documents on behalf of CONTRACTOR. Incomplete applications will be returned without action.

5. Entries shall match data on Schedule of Values and CONTRACTOR's Construction Schedule. Use updated Schedules if revisions have been made.
 6. Include amounts of Change Orders and Work Change Directives issued prior to the last day of the construction period covered by the application.
 7. Submit 4 executed copies of each Application for Payment to ENGINEER; including waivers of lien and similar attachments.
 8. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to ENGINEER.
- D. Application for Payment at Substantial Completion:
1. Following issuance of the Certificate of Substantial Completion, submit an Application for Payment; this application shall reflect any Certificates of Partial Substantial Completion issued previously for OWNER occupancy of designated portions of the Work.
 2. Administrative actions and submittals that shall proceed or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Test/adjust/balance records.
 - d. Maintenance instructions.
 - e. Meter readings.
 - f. Start-up performance reports.
 - g. Changeover information related to OWNER's occupancy, use, operation, and maintenance.
 - h. Final cleaning.
 - i. Application for reduction of retainage and consent of surety.
 - j. Final progress photographs.
 - k. List of incomplete Work, recognized as exceptions to ENGINEER'S Certificate of Substantial Completion.
- E. Final Payment Application: Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
1. Submit documents required for progress payments.
 2. Submit documents required in the General Conditions, as may be modified by the Supplementary Conditions.
 3. Completion of Project closeout requirements.
 4. Completion of items specified for completion after Substantial Completion.
 5. Transmittal of required Project construction records to OWNER.
 6. Proof that taxes, fees, and similar obligations have been paid.
 7. Submit Consent of Surety.
 8. Removal of temporary facilities and services.
 9. Completion of all punch list items.
 10. Submission of warranties
 11. Submission of operation and maintenance materials
 12. Completion of record drawings
 13. Removal of surplus materials, rubbish, and similar elements.
 14. Releases of Waivers of Lien Rights:
 - a. When submitting releases of waivers of lien rights, provide release or waiver by CONTRACTOR of each SUBCONTRACTOR and supplier that provided CONTRACTOR with labor, material, or equipment.
 - b. Provide a list of Subcontractors and Suppliers for which release or waiver of lien is required.

- c. Each release or waiver of lien shall be signed by an authorized representative of entity submitting release or waiver to CONTRACTOR, and shall include Subcontractor's or Supplier's corporate seal if applicable.
- d. Release or waiver of lien may be conditional upon receipt of final payment..

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01310 - PROJECT COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and supervisory requirements necessary for Project coordination including, but not necessarily limited to:
1. Coordination of Work under this Contract.
 2. Scheduling
 3. Permits
 4. Administrative and supervisory personnel.
 5. Land survey work.
 6. Pre-Construction Conference.
 7. Progress meetings.
 8. Inspections
 9. Start-up
 10. General installation provisions.
 11. Cleaning and protection.
- B. Related Sections Specified Elsewhere:
1. Equipment installation check, and operation, maintenance, and training of OWNER's personnel are included in Section 01600 and Sections for specific equipment items.
 2. Requirements for CONTRACTOR's Construction Schedule are included in Section 01330.
 3. Liquidated Damages in Section 01110

1.02 DEFINITIONS

- A. Monument: The term "monument" shall be considered as any object defining the location of a property corner, street location, section line, fractional section line, right-of-way marker, or other delineation of land ownership or division.

1.03 SUBMITTALS

- A. Within 15 days of Notice to Proceed, submit a list of CONTRACTOR's principal staff assignments, including the Superintendent and other personnel in attendance at Site; identify individuals, their duties and responsibilities; list their addresses and telephone numbers.

1.04 SCHEDULING

- A. Coordinate construction operations included under different Sections of the Specifications that are dependent upon each other for proper installation, connection, and operation. Where installation of one part of the Work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair. Make adequate provisions to accommodate items scheduled for later installation. CONTRACTOR shall coordinate the general construction including the work of subcontractors.

- B. CONTRACTOR shall coordinate work with the Ann Arbor Airport, the Federal Aviation Agency (FAA), the Michigan Department of Transportation (MDOT), DTE Energy, Pittsfield Township (project is located within Pittsfield Township), and the Washtenaw County Water Resources Commissioner. This will include, but not limited to, the following actions:
 - 1. Applying for a permit with the FAA to complete work including erection of cranes and equipment booms
 - 2. Applying for building permits, soil erosion and sedimentation control permits, and drain crossing permits. CONTRACTOR shall comply with the conditions of the permits.
 - 3. Complying with the permit requirements including restrictions on the heights of equipment and times when tall equipment can be erected
 - 4. Performing background checks on employees
 - 5. Communicating with the Ann Arbor Airport staff ahead of times when tall equipment will be used
 - 6. Scheduling deliveries
 - 7. Locating and coordinating overhead and underground utility construction

- C. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at Site in accordance with Laws or Regulations. CONTRACTOR shall train CONTRACTOR's employees on use of these sheets and shall keep a master copy on hand at Site.

- D. Coordination with Other Contractors:
 - 1. CONTRACTOR shall so conduct CONTRACTOR's operations as not to interfere with or injure the Work of other Contractors or workmen employed on adjoining or related Work, and CONTRACTOR shall promptly make good any injury or damage which may be done to such Work by CONTRACTOR or CONTRACTOR's employees or agents.
 - 2. Should a contract for adjoining Work be awarded to another CONTRACTOR, and should the Work on one of these contracts interfere with that of the other, ENGINEER shall decide which contract shall cease Work for the time being and which shall continue, or whether Work on both contracts shall continue at the same time and in what manner.

- E. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of schedules.
 - 2. Installation and removal of temporary facilities.
 - 3. Delivery and processing of submittals.
 - 4. Progress meetings.
 - 5. Project closeout activities.

1.05 PERMITS

- A. It is the responsibility of the CONTRACTOR to obtain and pay for any permits required to complete the work.

1.06 PRE-CONSTRUCTION CONFERENCE

- A. ENGINEER will schedule a Pre-Construction Conference and organizational meeting at the Site or other convenient location prior to commencement of construction activities to review responsibilities and personnel assignments.
- B. Attendees: OWNER, ENGINEER and ENGINEER's consultants, CONTRACTOR and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the Work.
- C. Agenda: Discuss items of significance that could affect progress including such topics as:
 - 1. Tentative Construction Schedule.
 - 2. Critical Work sequencing.
 - 3. Designation of responsible personnel.
 - 4. Procedures for processing field decisions and Change Orders.
 - 5. Procedures for processing Applications for Payment.
 - 6. Distribution of Contract Documents.
 - 7. Submittal of Shop Drawings, product data, and samples.
 - 8. Preparation of Record Documents.
 - 9. Use of the premises.
 - 10. Office, Work, and storage areas.
 - 11. Equipment deliveries and priorities.
 - 12. Safety procedures.
 - 13. First aid.
 - 14. Security.
 - 15. Housekeeping.
 - 16. Working hours.

1.07 PROGRESS MEETINGS

- A. Attendees: In addition to representatives of OWNER and ENGINEER, each subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings by persons familiar with the Project and authorized to conclude matters relating to progress.
- B. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the current status of the Project.
- C. CONTRACTOR's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to CONTRACTOR's Construction Schedule, whether on time or ahead or behind 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.
- D. Reporting: ENGINEER will prepare and distribute copies of minutes of the meeting to each party present and to other parties who should have been present. The minutes will include a brief summary, in narrative form, of progress since the previous meeting and report.

- E. Schedule Updating: CONTRACTOR shall revise Construction Schedule after each progress meeting where revisions to Schedule have been made or recognized. Issue revised Schedule no later than 3 days after the progress meeting date to ENGINEER for distribution concurrently with the progress meeting minutes.

1.08 INSPECTIONS

- A. CONTRACTOR shall participate in inspections with OWNER and ENGINEER as needed throughout the project.

1.09 LOCK-OUT/TAG-OUT

- A. CONTRACTOR shall be responsible for locking and tagging all valves and electrical equipment.

1.10 START-UP

- A. CONTRACTOR shall coordinate the start-up of motors, electrical equipment and pumps with the City. The City shall be notified not less than 4 weeks prior to start-up.

1.11 NOTIFICATIONS

- A. The City of Ann Arbor requires notification of staff prior to assisting with valve operation and pump start-up. Well water service must be maintained at all times. Time requirements for advanced notification and penalties for noncompliance follows:

<u>Item</u>	<u>Notice to OWNER (days)</u>	<u>Liquidated Damages</u>
Valve Operation	7	\$250/day
Well house out of service	7	\$250/day

1.12 SITE SUPERINTENDENT

- A. CONTRACTOR shall provide a site superintendent present at all times work under the contract is being completed. The site superintendent shall have the authority to make decisions on all aspects of work in this contract.

PART 2 - PRODUCTS

NOT USED

PART 3 – EXECUTION

3.01 LAND SURVEY WORK

A. SURVEY

1. Any monuments damaged or destroyed by CONTRACTOR that are not within the normal Work area as determined by ENGINEER shall be replaced, and CONTRACTOR shall pay all costs of the replacement survey. The replacement survey shall be performed by, or under, the direct supervision of a Registered Land Surveyor, licensed in the State in which the Work is performed.
2. All survey layout required for completion of the project is the responsibility of the CONTRACTOR. Verify layout information shown on Drawings, in relation to the property survey and existing benchmarks before proceeding to layout the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.
 - a. Record benchmark locations, with horizontal and vertical data, on Contract Record Documents.
3. Promptly replace lost or destroyed Project control points. Base replacements on the original survey control points.
4. Advise entities engaged in construction activities, of marked lines and levels provided for their use.
5. As construction proceeds, check every major element for line, level and plumb.
6. Site Improvements: Locate and lay out site improvements, including pavements, stakes for grading, fill and topsoil placement, utility slopes, and invert elevations by instrumentation and similar appropriate means.
7. Building Lines and Levels: Locate and lay out batter boards for structures, building foundations, column grids and locations, floor levels, and control lines and levels required for mechanical and electrical Work.
8. Existing Utilities and Equipment:
 - a. The existence and location of underground and other utilities and construction as shown on Drawings as existing are not guaranteed. Before beginning Site Work, CONTRACTOR shall investigate and verify the existence and location of underground utilities and other construction.
 - b. Furnish information necessary to adjust, move, or relocate existing structures, utility poles, lines, services, or other appurtenances located in or affected by construction. Coordinate with local authorities having jurisdiction.
 - c. Prior to construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water service piping.

3.02 CLEANING AND PROTECTION

- A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

- B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

END OF SECTION

SECTION 01330 - SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals, including, but not necessarily limited to, the following:
 - 1. CONTRACTOR's Construction Schedule.
 - 2. Submittal Schedule.
 - 3. Shop Drawings.
 - 4. Product data.
 - 5. Samples.
 - 6. Progress photographs.
 - 7. Record photographs.

- B. Topics covered elsewhere include, but are not limited to:
 - 1. Permits.
 - 2. Applications for payment.
 - 3. Performance and payment bonds.
 - 4. Insurance certificates.
 - 5. List of subcontractors.
 - 6. Demonstration and Training

1.02 SCHEDULE OF VALUES

- A. Within fourteen (14) days after issuance of Notice to Proceed, CONTRACTOR shall submit two (2) copies of the proposed schedule of values for the ENGINEER's review and approval.
- B. Schedule of values shall meet requirements of Section 01290.
- C. Schedule of values shall be revised as needed based on ENGINEER's comments.
- D. Schedule of values shall be organized according to specification divisions.
- E. Schedule of values shall include sections for tracking all costs associated with each stage of the project.

1.03 SUBMITTALS

- A. Bonds and Insurance Certificates shall be submitted to and approved by OWNER and ENGINEER prior to the initiation of any construction on Site.
- B. 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, and similar documents; correspondence and records established in conjunction with compliance with standards; and regulations bearing upon performance of the Work.

1.04 SUBMITTAL PROCEDURES

A. Coordination:

1. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
4. ENGINEER reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Processing:

1. Allow sufficient review time so that installation shall not be delayed as a result of the time required to process submittals, including time for resubmittals.
2. ENGINEER will review and return submittals with reasonable promptness, or advise CONTRACTOR when a submittal being processed must be delayed for coordination or receipt of additional information by putting the submittal "On Hold" and returning a transmittal identifying the reasons for the delay.
3. No extension of Contract Time will be authorized because of failure to transmit submittals to ENGINEER sufficiently in advance of the Work to permit processing.

C. Submittal Preparation:

1. Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
2. Provide a space approximately 4 inches by 5 inches on the label or beside the title block on submittals not originating from CONTRACTOR to record CONTRACTOR's review and approval markings and the action taken.
3. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of ENGINEER.
 - d. Name and address of CONTRACTOR.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
4. Any markings done by CONTRACTOR shall be done in a color other than red. Red is reserved for ENGINEER's marking.
5. The number of copies to be submitted will be determined at the pre-construction conference. Reproducibles may be submitted and will be marked and returned to CONTRACTOR. Blue or black line prints shall be submitted in sufficient quantity for distribution to ENGINEER and OWNER recipients.

D. Submittal Transmittal:

1. Package each submittal appropriately for shipping and handling. This shall include an index either on the transmittal or within the submittal itself. Transmit each submittal from CONTRACTOR to ENGINEER using a transmittal form. Submittals received from sources

other than CONTRACTOR will be returned without action. Use separate transmittals for items from different specification sections. Number each submittal consecutively. Resubmittals should have the same number as the original, plus a letter designation for each resubmittal (i.e., 7-A, 7-B, etc.).

2. Indicate on the transmittal relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include CONTRACTOR's certification that information complies with Contract Document requirements. On resubmittal, all changes shall be clearly identified for ease of review. Resubmittals shall be reviewed for the clearly identified changes only. Any changes not clearly identified will not be reviewed and original submittal shall govern.

1.05 CONSTRUCTION SCHEDULE

- A. Within fourteen (14) days after issuance of the Notice to Proceed, the CONTRACTOR shall prepare three (3) copies of the proposed schedule and submit two (2) copies to the ENGINEER for review and approval. Hard copies of project schedule shall be in color with critical path shown. CONTRACTOR shall also submit electronic copy of schedule.
 1. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on Schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the Work.
 2. Coordinate Construction Schedule with Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
 3. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on Schedule to allow time for ENGINEER's procedures necessary for certification of Substantial Completion.
- B. Schedule Updating: Revise Schedule after each meeting or activity where revisions have been recognized or made within 2 weeks following the meeting or activity.

1.06 SUBMITTAL SCHEDULE

- A. After development and acceptance of Construction Schedule, prepare a complete Schedule of Submittals. Submit Schedule within 10 days of the date required for establishment of Construction Schedule.
- B. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products, as well as Construction Schedule.
- C. Prepare Schedule in chronological order; include submittals required during the first 90 days of construction. Provide the following information:
 1. Scheduled date for the first submittal.
 2. Related Section number.
 3. Submittal category.
 4. Name of subcontractor.
 5. Description of the part of the Work covered.
 6. Scheduled date for resubmittal.
 7. Scheduled date ENGINEER's final release or approval.

- D. Following response to initial submittal, print and distribute copies to ENGINEER, OWNER, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project meeting room and field office.
- E. When revisions are made, distribute 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 construction activities.
- F. Schedule Updating: Revise Schedule after each meeting or activity where revisions have been recognized or made within 48 hours following the meeting or activity.

1.07 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings. Include the following information:
 - 1. Dimensions.
 - 2. Identification of products and materials included.
 - 3. Compliance with specified standards.
 - 4. Notation of coordination requirements.
 - 5. Notation of dimensions established by field measurement.
- C. Nameplate data for equipment including electric motors shall be included on Shop Drawings. Electric motor data shall state the manufacturer, horsepower, service factor, voltage, enclosure type, oversize wiring box, etc.
- D. Shop Drawings shall indicate shop painting requirements to include type of paint and manufacturer.
- E. Standard manufactured items in the form of catalog work sheets showing illustrated cuts of the items to be furnished, scale details, sizes, dimensions, quantity, and all other pertinent information should be submitted and approved in a similar manner.
- F. Measurements given on Shop Drawings or standard catalog sheets, as established from Contract Drawings and as approved by ENGINEER, shall be followed. When it is necessary to verify field measurements, they shall be checked and established by CONTRACTOR. The field measurements so established shall be followed by CONTRACTOR and by all affected trades.
- G. Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 inches by 11 inches but no larger than 36 inches by 48 inches.
- H. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.08 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as Shop Drawings.
- B. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:
 - 1. Manufacturer's printed recommendations.
 - 2. Compliance with recognized trade association standards.
 - 3. Compliance with recognized testing agency standards.
 - 4. Application of testing agency labels and seals.
 - 5. Notation of dimensions verified by field measurement.
 - 6. Notation of coordination requirements.
- C. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

1.09 SAMPLES

- A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
- B. Mount, display, or package Samples in the manner specified to facilitate review of qualities indicated. Prepare Samples to match ENGINEER's Sample. Include the following:
 - 1. Generic description of the Sample.
 - 2. Sample source.
 - 3. Product name or name of manufacturer.
 - 4. Compliance with recognized standards.
 - 5. Availability and delivery time.
- C. 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 the final submittal and the actual component as delivered and installed.
- D. Where variation in color, pattern, texture, or other characteristics are inherent in the material or product represented, submit multiple units (not less than 3) that show approximate limits of the variations.
- E. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.

- F. Preliminary Submittals: Where Samples are for selection of color, pattern, texture, or similar characteristics from a range of standard choices, submit a full set of choices for the material or product.
 - 1. Preliminary submittals will be reviewed and returned with ENGINEER's mark indicating selection and other action.
- G. Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit 3 sets; 1 will be returned marked with the action taken.
- H. Maintain sets of Samples, as returned, at the Site, for quality comparisons throughout the course of construction.
- I. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
- J. Sample sets may be used to obtain final acceptance of the construction associated with each set.

1.10 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, ENGINEER will review each submittal, mark to indicate action taken, and return promptly.
 - 1. Compliance with specified characteristics is CONTRACTOR's responsibility.
- B. Action Stamp: ENGINEER will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
 - 1. Final Unrestricted Release: Where submittals are marked "No Exceptions Taken," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
 - 2. Final-But-Restricted Release: When submittals are marked "Furnish as Corrected," that part of the Work covered by the submittal may proceed, provided it complies with notation or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
 - 3. Returned for Resubmittal: When submittal is marked "Rejected" or "Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
 - a. Do not permit submittals marked "Rejected" or "Revise and Resubmit" to be used at Site, or elsewhere where Work is in progress.
 - 4. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Acknowledge Receipt."
 - 5. The approval of ENGINEER shall not relieve CONTRACTOR of responsibility for errors on Drawings or submittals as ENGINEER's checking is intended to cover compliance with Drawings and Specifications and not enter into every detail of the shop work.

1.11 RECORD PHOTOGRAPHS

- A. CONTRACTOR shall take a minimum of 36 pre-construction photographs to document the condition of the site prior to beginning work. These photos should document the conditions of the well houses, well house floors, duct bank runs, county drain, access roads, adjacent trees, fences, and State Road.
- B. After final acceptance of the Work, 36 photographs shall be taken of each structure and major feature of the Project as directed by ENGINEER. These photographs shall be taken from points and at times directed by ENGINEER.
- C. Photographs shall include condition of State Road, both before and after project.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

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SECTION 01450 – QUALITY CONTROL

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Quality control and control of installation.
- B. References.
- C. Testing and inspection services.
- D. Manufacturers' field services

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturer's instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on Shop Drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. All materials and equipment shall be new, unless otherwise noted.

1.03 REFERENCES

- A. Conform to reference standard by date of issue current on date of Contract Documents.
- B. Should specified reference standards conflict with Contract Documents, request clarification from the ENGINEER before proceeding.
- C. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the ENGINEER shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.04 TESTING AND INSPECTION SERVICES

- A. CONTRACTOR shall be responsible for providing, paying for, coordinating and scheduling the services of an independent testing firm (acceptable to OWNER) to perform all materials and compaction testing and related tasks.
- B. The independent firm will perform tests, inspections and other services, specified in individual specification sections and as required by the ENGINEER.
- C. Acceptable testing companies for selection by the CONTRACTOR (excluding paint testing) are:
 - 1. CTI (Wixom, Michigan; Telephone: (248) 486-5100)
 - 2. SME (Plymouth, Michigan; Telephone (734) 454-9900)
 - 3. PSI (Plymouth, Michigan; Telephone: (734) 453-7900)
 - 4. Haengel and Associates (Canton, Michigan; Telephone (734) 455-9771)
 - 5. TEC (Ann Arbor, Michigan; Telephone: (734) 623-0400)
- D. Acceptable testing companies for selection by the CONTRACTOR for painting are:
 - 1. Dixon Engineering (Lake Odessa, Michigan; Telephone: (616) 374-3221)
 - 2. Nelson Tank (Lansing, Michigan: (517) 321-1692)
- E. Testing, inspections and source quality control may occur on or off the project site. Perform off-site testing as required by the ENGINEER or OWNER.
- F. Reports will be submitted by the independent firm to the ENGINEER and CONTRACTOR, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
 - 1. Notify ENGINEER and independent firm a minimum of 24 hours prior to expected time for operations requiring services.
 - 2. Make arrangements with independent firm and pay for additional samples and tests required for CONTRACTOR's use.
- G. Independent testing firm will provide the testing services listed below. Any additional required by the Contract Documents beyond what is listed, shall be provided by the CONTRACTOR.
 - 1. Backfill
 - a. Sieve analysis per source.
 - b. Proctor per source
 - c. Compaction testing at 400 SF intervals per lift, as required.
 - 2. Aggregate Base
 - a. Sieve analysis per source.
 - b. Proctor per source.
 - c. Compaction testing once per 1,000 SF of placement.
 - 3. Concrete
 - a. A concrete test shall be performed on each truck bringing materials to the site.
 - 4. Grout and Mortar
 - a. Compressive strength. Four (4) cylinders each with laboratory testing.
 - b. Prism tests. Conduct one test for each type of wall construction indicated.

5. Painted Surfaces
 - a. Verify coatings and other materials are as specified.
 - b. Verify surface preparation and applications are as specified.
 - c. Visually inspect all welds prior to coating.
 - d. Verify DFT of each coat and total DFT of each coating systems are as specified using wet film and dry film gauges.
 - e. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.

- H. CONTRACTOR shall not perform the work without the independent firm on site performing the required tests.

- I. Testing and employment of testing agency or laboratory shall not relieve CONTRACTOR of obligation to perform Work in accordance with requirements of Contract Documents.

- J. The independent firm on instructions by the ENGINEER shall perform re-testing or re-inspection required because of non-conformance to specified requirements. Payment for re-testing or re-inspection will be the responsibility of the CONTRACTOR.

- K. Agency Responsibilities:
 1. Test samples of mixes submitted by CONTRACTOR.
 2. Provide qualified personnel at site. Cooperate with ENGINEER and CONTRACTOR in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 5. Promptly notify ENGINEER and CONTRACTOR of observes irregularities or non-conformance of Work or products.
 6. Perform additional tests required by ENGINEER.

- L. Agency Reports: After each test, promptly submit two copies of report to ENGINEER and CONTRACTOR. When requested by ENGINEER, provide interpretation of test results. Include the following:
 1. Date issued.
 2. Project title and number.
 3. Name of inspector.
 4. Date and time of sampling or inspection.
 5. Identification of product and specifications section.
 6. Location in the Project.
 7. Type of inspection or test.
 8. Date of test.
 9. Results of tests.
 10. Conformance with Contract Documents.

- M. Limits On Testing Authority
 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency or laboratory may not approve or accept any portion of the Work.

3. Agency or laboratory may not assume any duties of CONTRACTOR.
4. Agency or laboratory has no authority to stop the Work.

1.05 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

NOT USED

END OF SECTION

SECTION 01500 - TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: This Section specifies procedural and administrative requirements for temporary services and facilities.
- B. Temporary Utilities include, but are not limited to:
 - 1. Water service and distribution.
 - 2. Temporary electric power.
 - 3. Temporary lighting.
 - 4. Public and private utilities coordination.
- C. Temporary Construction and Support Facilities include, but are not limited to:
 - 1. Temporary heating facilities.
 - 2. CONTRACTOR's field offices and storage sheds.
 - 3. Temporary roads and paving.
 - 4. Sanitary facilities.
 - 5. Dewatering facilities and drains.
- D. Construction Buildings and Facilities include, but are not limited to.
 - 1. Temporary enclosures.
 - 2. Temporary Project identification signs.
 - 3. Temporary Site identification signs.
 - 4. Temporary Project bulletin boards.
 - 5. Stairs.
 - 6. Hoists.
 - 7. Ongoing construction cleanup.
 - 8. Storage of equipment and material.
- E. Security and Protection Facilities required include, but are not limited to:
 - 1. Temporary fire protection.
 - 2. Permanent fire protection.
 - 3. Barricades, warning signs, lights.
 - 4. Enclosure fence for the Site.
 - 5. Security enclosure and lockup.
 - 6. Environmental protection.
 - 7. Control of noise.
 - 8. Dust control.
- F. Traffic Control Facilities required include, but are not limited to:
 - 1. Maintenance of traffic.
- G. Sedimentation Control Facilities required include, but are not limited to:
 - 1. Soil erosion and sedimentation control.
 - 2. Stormwater discharge control.
 - 3. Dewatering trenches and disposal of excess excavated material.

4. Slope protection - adjacent to stream crossings.
5. Slope protection.
6. Final topography protection.

1.02 REFERENCES

- A. Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994.
- B. Guidebook of Best Management Practices for Michigan Watersheds.
- C. Local Soil Erosion Control Ordinance or requirements.
- D. Codes and Standards:
 1. Comply with NFPA Code 241, "Building Construction and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library, "Temporary Electrical Facilities."
 2. Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services," prepared jointly by AGC and ASC, for industry recommendations.
 3. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 1. Soil Erosion and Sedimentation Control Program prepared by CONTRACTOR, as specified in this Section, shall be reviewed and have received at least preliminary concurrence from the local Enforcing Agent before it will be presented and discussed at the Pre-Construction Conference, at which time final revisions may be made. Copies of the final agreed program, and Act 451 Permit, shall be delivered to ENGINEER a minimum of 2 weeks prior to beginning any Work on Site.
 2. Temporary Utilities: Submit a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to OWNER, change over from use of temporary service to use of the permanent service.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to:
 1. Building Code requirements.
 2. Health and Safety regulations.
 3. Utility Company regulations.
 4. Police, Fire Department, and Rescue Squad rules.
 5. Environmental Protection regulations.
 6. State and Local Soil Erosion and Sedimentation Control regulations.
 7. National Fire Protection Association (NFPA):NFPA No.70-93
 8. National Electrical Code (NEC) and local amendments thereto.
 9. Comply with federal, state, and local codes and regulations, and utility company requirements.
 10. American Water Works Association and National Sanitation Foundation.
 11. UL

- B. Inspection: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.05 PROJECT CONDITIONS

- A. There is no electric service, sanitary service and limited raw water available at the project site. Unless otherwise provided in these Specifications, CONTRACTOR shall make CONTRACTOR's own arrangements for electricity, gas, water, and sewer services for use during the construction of the Work and shall pay for all temporary facilities, connections, extensions, and services.
 - 1. Cost or use charges for temporary facilities are not chargeable to OWNER or ENGINEER, and will not be accepted as a basis of claims for a Change Order.
 - 2. CONTRACTOR will be responsible for measuring and paying for any natural gas usage during construction.
- B. Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do no overload facilities or permit them to interfere with progress. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on Site.
- C. Special Requirements: Special requirements of OWNER and MDOT being specified for traffic control on State trunk lines and major arteries due to the magnitude of traffic disruption involved in this Contract.

1.06 SEQUENCING AND SCHEDULING

- A. CONTRACTOR shall inform the local Fire Department in advance of CONTRACTOR's program of street obstruction and detours, so that the Fire Department can set up plans for servicing the area in case of an emergency.
 - 1. CONTRACTOR shall also notify the public agency having jurisdiction over the roads at least 1 week prior to obstructing any street.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide new materials; if acceptable to ENGINEER, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.
- B. Water: Provide potable water approved by local health authorities.
- C. Seed: Provide in accordance with City of Ann Arbor Public Services Department Standard Specifications.
- D. Mulches: Provide in accordance with City of Ann Arbor Public Services Department Standard Specifications. Otherwise, mulches shall consist of 2 tons per acre of straw or hay. Chemical mulch or other approved material may be used.

2.02 EQUIPMENT

- A. Provide new equipment; if acceptable to ENGINEER, undamaged, previously used equipment in serviceable condition may be used. Provide equipment suitable for use intended.
- B. Electrical Outlets: Provide properly configured NEMA polarized outlets to prevent insertion of 110 to 120 volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.
- C. Electrical Power Cords: Provide grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas where construction activities are in progress.
- D. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.
- E. Temporary Offices: Provide prefabricated or mobile units or similar on-site construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air conditioned units on foundations adequate for normal loading.
- F. Temporary Toilet Units: Provide self-contained single-occupant toilet units, properly vented and fully enclosed with a glass fiber-reinforced polyester shell or similar nonabsorbent material.
- G. First Aid Supplies: Comply with governing regulations.
- H. Fire Extinguishers: Provide hand-carried, portable, UL rated, Class "A" fire extinguishers for temporary offices and similar spaces.
 - 1. In other locations, provide hand-carried, portable, UL rated, Class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
 - 2. Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.
- I. Bulletin Board: Provide a weather-protected enclosed bulletin board at Site. The bulletin board shall be mounted in a conspicuous and public outside location.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they shall serve the 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.

3.02 TEMPORARY UTILITY INSTALLATION

- A. Engage the appropriate local utility company to install temporary service or to connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
 - 1. Arrange with the company and existing users for a time when service can be interrupted, where necessary, to make connections for temporary services.
- B. Water Service and Distribution: CONTRACTOR shall at all times provide for CONTRACTOR's employees an abundant and convenient supply of cool drinking water taken from a potable source.
- C. Temporary Electric Power Service: Electric power service does not currently exist at the site. Contractor may use power upon installation of service. The power consumption will be metered and the contractor responsible for costs incurred. These costs will not be reimbursed through the project allowances.
- D. Temporary Lighting: Wherever overhead floor or roof deck has been installed, provide temporary lighting with local switching.
 - 1. Install and operate temporary lighting that shall fulfill security and protection requirements, without operating the entire system, and shall provide adequate illumination for construction operations and traffic conditions.
 - 2. When permanent lights and receptacles are installed in new areas of construction, CONTRACTOR may use them, provided CONTRACTOR reimburses OWNER for the energy consumed under the following conditions:
 - a. If the new lights and receptacles are placed on an extension of an existing distribution system, CONTRACTOR shall pay a prorated amount agreed to with OWNER if no meter exists to determine actual energy consumption.
 - b. If the new lights and receptacles are on a new service, CONTRACTOR shall pay the entire bill (which includes transformer losses, power factor penalties, minimum demand charges, energy adjustments, etc.) as metered on the new service. A new service is a plant connection provided under this Contract that will increase OWNER's electrical costs.
 - 3. CONTRACTOR shall investigate the billing structure before requesting the new service to be energized for facility construction purposes. Once energized, the service shall remain energized. Where a new service is required to provide test power to equipment for performance tests, power will not be paid for by OWNER until construction is 90 percent complete as determined by the payment certificates. Any costs associated with CONTRACTOR requests for power prior to the 90 percent construction completion will be paid for by CONTRACTOR. In no case shall OWNER begin paying the entire electrical bill until OWNER has beneficial use of the facilities.
- E. Public and Private Utilities: Where any utilities, water, sewer, gas, telephone, or any other either public or private, are encountered, CONTRACTOR must provide adequate protection for them, and CONTRACTOR shall be held responsible for any damages to such utilities arising from CONTRACTOR's operations.
- F. Water for Construction
 - 1. Owner will not provide water for cleaning or other purposes.
- G. Storm and Sanitary Sewers: Sewers are not available. If sewers are not available or cannot be used, provide portable units.

1. If gas is present in existing sewers or tanks where CONTRACTOR must work, they shall be cleared of gas before entering. If the gas cannot be removed by natural ventilation by the removal of covers, CONTRACTOR shall maintain forced draft to render the area safe as determined by gas detection equipment.
2. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
3. Connect temporary sewers to the municipal system as directed by the sewer department officials.
4. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. Following heavy use, restore normal conditions promptly.
5. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of stormwater from heavy rains.

3.03 TEMPORARY CONSTRUCTION AND SUPPORT FACILITIES INSTALLATION

- A. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
 1. Maintain temporary construction and support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to OWNER.
 2. Provide incombustible construction for offices, shops, and sheds located within the construction area, or within 30 feet of building lines. Comply with requirements of NFPA 241.
- B. Temporary Heating Facilities: Provide temporary heat required by construction activities for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
 1. Except where use of the permanent system is authorized, provide vented self-contained LP gas or fuel oil heaters with individual space thermostatic control.
 2. Use of gasoline-burning space heaters, open flame, or salamander-type heating units is prohibited.
- C. CONTRACTOR's Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at Site. Keep the office clean and orderly for use for small progress meetings.
- D. Sanitary Facilities: Sanitary facilities include temporary toilets, wash facilities, and drinking water fixtures. Comply with regulations and health Codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best service the Project's needs.
 1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.
 2. Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
 3. Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
- E. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with

dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the Site, excavations, and construction free of water.

3.04 CONSTRUCTION BUILDINGS AND FACILITIES INSTALLATION

- A. Storage platforms, sheds, temporary closures for doors, windows and other openings of buildings, temporary sidewalks, runways, and ladders shall be provided.
 - 1. Hazardous areas shall be protected by guardrails and fences. Storage platforms and sheds shall be provided for materials which require protection from the weather.
 - 2. Sheds shall be substantially constructed and covered with "ready roofing." Doors, windows, and other openings in the permanent work shall be closed as soon as necessary to safeguard the construction and materials from tampering or damage.
 - 3. Enclosures for openings easily accessible from the exterior shall be of solid wood or sash, provided with necessary hardware and padlocks. Other openings shall be enclosed by old sash or canvas on wooden frames for the protection of the building against damage by weather.
 - 4. Enclosures shall be weathertight and secured in such manner as not to damage the finish of the building.

- B. Temporary Enclosures: Provide temporary enclosure for protection of construction in progress and completed, from exposure, foul weather, other construction operations and similar activities.
 - 1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 - 2. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of 25 square feet or less with plywood or similar materials.
 - 3. Close openings through floor or roof decks and horizontal surfaces with load-bearing wood-framed construction.

- C. Temporary Project Bulletin Board: As a minimum, the following items must be posted:
 - 1. Wage Rates (when applicable).
 - 2. Safety Poster (OSHA or State OSHA).
 - 3. Nondiscrimination Poster.
 - 4. Equal Employment Opportunity Statement signed by a Company official.
 - 5. All permits

- D. Hoists: CONTRACTOR shall provide temporary hoists to lift building materials and equipment to the intended areas. Hoists shall be capable of carrying the intended load without exceeding the load limitation of the hoisting device.

- E. Ongoing Construction Cleanup: Project cleanup shall be an ongoing operation. CONTRACTOR shall maintain an order of neatness and good housekeeping comparable to that maintained by OWNER. Project cleanup applies to the Site and all areas affected by construction operations. CONTRACTOR shall:
 - 1. Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.

2. Maintain dirt and debris resulting from CONTRACTOR's operations in designated spoil piles as approved by ENGINEER or remove from the Site daily. Dirt and debris shall not collect or interfere with OWNER's facility operations. Excess dirt and debris shall be removed from the Site as needed to confine spoil piles in designated areas.
 3. Perform general cleanup inside of OWNER's buildings at least once every two weeks. Cleanup shall include consolidation of stored materials, removal of waste material and debris, and sweeping of flooring surfaces.
 4. Maintain clear access to all properties affected by construction activities. Maintain unobstructed access to existing buildings, equipment, safety equipment, and other items requiring OWNER access for facility operation.
 5. Keep tools, equipment, and materials in a neat and orderly arrangement.
 6. Maintain culverts, sewers, and drainage structures by removing sediment and debris from construction operations.
 7. Repair all holes and ruts resulting from construction operations that affect OWNER's use of property with approved material; compact, level, and restore.
- F. Storage of Equipment and Material: Pumps and other machinery units shall be stored in weathertight structures provided by CONTRACTOR.
1. Motors, electrical switchgear, gauges, and other equipment of a delicate nature, as determined by ENGINEER, shall be stored in weathertight warehouses which are maintained at a temperature of at least 60 degrees F.
 2. Structural steel, miscellaneous and cast iron items may be placed in open yard storage, but any such items having attached motors or other machinery units shall have such units well wrapped with waterproof paper or cloth for protection from the weather.
 3. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of ENGINEER.
 4. Materials and equipment distributed, stored, and placed upon or near the Site of the Work shall at all times be so disposed as not to interfere with work prosecuted by OWNER or other Contractors in the employment of OWNER or with drainage. Materials and equipment shall not be stored on public streets.

3.05 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer as requested by ENGINEER.
- B. Temporary Fire Protection: Until fire protection needs are supplied by permanent facilities, install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10, "Standard for Portable Fire Extinguishers," and NFPA 241, "Standard for Safeguarding Construction, Alterations and Demolition Operations."
 1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than 1 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 fighting fires. Prohibit smoking in hazardous fire exposure areas.

4. Provide supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.
- C. Barricades, Warning Signs, and Lights: Comply with Standards and Code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.
 - D. Private Owner Fences: No fences shall be removed or destroyed by CONTRACTOR without the written permission of ENGINEER. CONTRACTOR shall be held fully responsible for any damages caused by CONTRACTOR's work to adjoining fences. Fences that have to be removed shall be preserved and replaced in a manner acceptable to ENGINEER. Damaged material shall be replaced by new material.
 - E. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
 1. Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
 - F. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the Site.
 - G. Control of Noise: CONTRACTOR shall eliminate noise to as great an extent as possible at all times. Air compressors shall be equipped with silencers, and the exhaust of all gasoline motors and other power equipment shall be provided with mufflers.
 1. CONTRACTOR shall require strict observances of all pertinent ordinances and regulations. Any blasting permitted in such locations shall be done with reduced charges.
 - H. On-Site Burning: Burning of waste materials resulting from the Work under this Contract will not be allowed unless authorized in writing by OWNER. Where burning is not allowed, CONTRACTOR shall haul all waste materials from Site and dispose of same in a manner acceptable to ENGINEER.
 1. The costs of hauling and disposal of waste materials shall be included in other items of the Work under this Contract.
 - I. Dust Control: CONTRACTOR shall take all steps necessary for the alleviation or prevention of dust nuisance caused by or resulting from CONTRACTOR's operations and shall apply water or dust palliative, or both, as required. No direct payment will be made for any such Work performed or materials used to control dust from this Contract.

3.06 SEDIMENTATION CONTROL FACILITIES INSTALLATION

- A. Soil Erosion and Sedimentation Control: CONTRACTOR shall take all precautions necessary to prevent soil erosion of areas disturbed by the construction and shall ensure that all soil erosion be contained within the construction Site. CONTRACTOR shall provide temporary slope protection,

temporary dikes, etc., as required to prevent eroded materials from entering any sewers or natural watercourses.

1. CONTRACTOR shall comply with Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994, Part 91 of the Michigan Compiled Laws and local city or county soil erosion control programs.
 2. CONTRACTOR shall prepare a Soil Erosion and Sedimentation Control Program for submittal to and approval by Local Soil Erosion and Sedimentation Control Agent prior to start of construction, as required in the following paragraphs. Copies of State guidelines "Better Environment through Soil Erosion and Sedimentation Control" and "Protection of Natural Resources" DEQ Handbook of Specifications may be obtained at no charge from the Michigan Department of Environmental Quality (MDEQ). The "Michigan Soil Erosion and Sedimentation Control Guidebook" and the "Guidebook of Best Management Practices for Michigan Watersheds" may also be obtained from MDEQ.
 3. Since it is impractical to identify specific potential soil erosion problems along a water main route, CONTRACTOR, after award but prior to the Pre-Construction Conference, together with the local soil erosion Enforcing Agent, shall identify all potential soil erosion problem areas and prepare a detailed Soil Erosion and Sedimentation Control Program satisfying CONTRACTOR's specific method of operation. This program shall include as a minimum, but not necessarily be limited to, the following:
 - a. Identify on a separate set of Drawings all soil erosion problem areas.
 - b. Identify specific control structure using DEQ United Keying System from the "Michigan Soil Erosion and Sedimentation Control Guidebook" to be placed to control erosion and to prevent soil from entering storm sewers and streams.
 - c. Indicate timing of placement and removal of structures both in relationship to time of year and to sequence of construction.
 - d. Indicate timing of completion of cleanup and surface restoration after control structures are removed.
 4. The Soil Erosion and Sedimentation Control Program, prepared by CONTRACTOR, shall be reviewed and have received at least preliminary concurrence from the local Enforcing Agent before it will be presented and discussed at the Pre-Construction Conference, at which time final revisions may be made. Copies of the final agreed program shall be made available for ENGINEER and the local Enforcing Agent. Should the local regulatory agency determine at any time during construction that the construction operation is in violation of the Act and cite OWNER, CONTRACTOR or subcontractor shall take immediate action, as directed by OWNER, to ensure compliance with the Act.
- B. Stormwater Discharge Control:
1. CONTRACTOR shall comply with Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994, Part 31 of the Michigan Compiled Laws and local city or county stormwater discharge control programs.
 2. CONTRACTOR shall not begin any Work at Site until the stormwater discharge permit has been obtained for the Project.
 - a. CONTRACTOR shall indemnify OWNER against any and all fines for discharge permit violations which are assessed against OWNER, and which are due to CONTRACTOR's actions or failure to maintain the sedimentation control measures.
 3. CONTRACTOR shall utilize the appropriate Best Management Practices to prevent any of CONTRACTOR's activities from resulting in an unlawful discharge of pollutants to the waters of the State. CONTRACTOR shall correct any deficiencies noted by ENGINEER, Local Enforcement Agency or MDEQ within 24 hours of receiving written notice that corrections are necessary. Should CONTRACTOR fail to take action within the allotted time, OWNER shall

have the right to perform the work and deduct all costs from amounts due CONTRACTOR under this Contract.

C. Dewatering Trenches and Disposal of Excess Excavated Material:

1. Pumping or draining from trench excavations shall be made on either side of the ductbank and not into the waters of the State. It shall be CONTRACTOR's responsibility to secure the necessary approval of private landowners before discharging water from the trench excavation onto private lands. Water shall be discharged in such a manner as to cause no pollution or erosion problems.
2. CONTRACTOR shall dewater to existing storm sewer systems wherever possible; method of disposal shall be approved by OWNER. All discharge from dewatering wells discharged onto the ground ahead of being piped to a natural watercourse or lake via an existing storm sewer system or by a temporary piping system shall have built at the point of entry into such storm sewer a silt retention structure.
3. The silt retention structure may consist of several straw bales adequately anchored and placed as directed by ENGINEER. Any eventual silt or solids retained in the area of these structures shall be removed prior to removal of the structure. At no time will silt or similar materials be permitted to filter into a lake or natural watercourse. There shall be no sidecasting of any excavated material into any waterway. Excess excavated material from stream crossings and excavation near streams shall be removed and disposed of elsewhere, and not within the floodplain.

D. Slope Protection: On slopes greater than 20 percent, but not immediately adjacent to stream crossing, mulch shall be anchored with a spray of asphalt, Type SS-1S emulsion mixed with an equal amount of water at a rate of 200 gallons per acre. Chemical self-adhering mulch may be used. Mulch shall be anchored on slopes greater than 10 percent if immediately adjacent to stream crossings. Mulch may also be held in place by discing with a farm disc. If mulch materials such as netting or excelsior blankets are used, they may have to be pegged.

E. Final Topography Protection: When final topography has been established, all bared soil shall be seeded, fertilized, and mulched in an effort to restore to a protected condition, except in flat, active farm fields.

1. The permanent protection measures shall be in effect not more than 30 days after the earth change is completed, except at tie-in areas at both sides of the stream where temporary measures will be installed within 3 days following a pipeline crossing. Temporary measures may include a row of sandbags at the top of the bank, a row of pegged bales of straw, or an earth berm or diversion ditch. These temporary measures shall be maintained until permanent measures are installed.
2. Where construction involves placing pipes in roadways or under other impervious materials, special care shall be provided by CONTRACTOR.
3. Provide control measures at all storm sewer catch basins by providing straw or other types of filters or construct sediment traps adjacent to inlets.
4. If a roadway has a grass ditch area, minimize disturbance and provide filter berms (straw or gravel) or sediment traps as appropriate.
5. Provide proper downdrain structures to control increased runoff to streams and drains.
6. Stabilize the roadway as soon as possible after placement of the utility. Temporary erosion control measures shall be instituted until final paving is complete. Such measures may include a subbase surfacing application or gravel surfacing. Compaction of soil may suffice if other control measures are effected.

3.07 FIELD QUALITY CONTROL

- A. Any unforeseen situations that may be encountered during the course of construction that may cause accelerated erosion and deposition of sediment into waterways and/or lakes shall be controlled by methods that may include sediment traps, sediment basins, or holding ponds. Any slope failures or development of gullies after construction has been completed shall be corrected immediately.
- B. Should the local Regulatory Agency determine at any time during construction that the construction operation is in violation of the Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994 and cite OWNER, CONTRACTOR or Subcontractor shall take immediate action, as directed by OWNER, to ensure compliance with the Act.

3.08 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour-day basis where required to achieve indicated results and to avoid possibility of damage.
- C. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- D. Termination and Removal: Unless ENGINEER requires that it be maintained longer, remove each temporary facility when the need has ended, or when 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 the 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 property of CONTRACTOR. OWNER reserves the right to take possession of Project identification signs.
 - 2. At Substantial Completion, clean and renovate permanent facilities that have been used during the construction period including, but not limited to:
 - a. Replace air filters and clean inside of ductwork and housings.
 - b. Replace significantly worn parts and parts that have been subject to unusual operating conditions.
 - c. Replace lamps that are burned out or noticeably dimmed by substantial hours of use.

END OF SECTION

SECTION 01534 - PROTECTION of ENVIRONMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Contractor in executing work shall maintain work areas, on-and-off site, free from environmental pollution that would be in violation of federal, state, or local regulations.

1.02 PROTECTION of SEWERS

- A. Take adequate measures to prevent impairment of operation of existing sewer system. Prevent construction material, pavement, concrete, earth, or other debris from entering sewer or sewer structure.

1.03 PROTECTION of WATERWAYS

- A. Observe rules and regulations of local and state agencies, and agencies of U.S. government prohibiting pollution of any lake, stream, river, or wetland by dumping of refuse, rubbish, dredge material, or debris therein.
- B. Provide containment that will divert flows, including storm flows and flows created by construction activity, to prevent loss of residues and excessive silting of waterways or flooding damage to property.
- C. Comply with procedures outlined in U.S. EPA manuals entitled "Guidelines for Erosion and Sedimentation Control Planning and Implementation," Manual EPA-72-015 and "Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity," Manual EPA 43019-73-007.

1.04 DISPOSAL of EXCESS EXCAVATED and OTHER WASTE MATERIALS

- A. Dispose waste material in accordance with federal and state codes, and local zoning ordinances.
- B. Unacceptable disposal sites include, but are not limited to, sites within wetland or critical habitat, and sites where disposal will have detrimental effect on surface water or groundwater quality.
- C. Make arrangements for disposal subject to submission of proof to engineer that owner(s) of proposed site(s) has valid fill permit issued by appropriate government agency and submission of haul route plan, including map of proposed route(s).
- D. Provide watertight conveyance for liquid, semi-liquid, or saturated solids that tend to bleed during transport. Liquid loss from transported materials not permitted, whether being delivered to construction site or hauled away for disposal. Fluid materials hauled for disposal must be specifically acceptable at selected disposal site.

1.05 PROTECTION of AIR QUALITY

- A. Contain paint aerosols and V.O.C.'s by acceptable work practices.
- B. Minimize air pollution by requiring use of properly operating combustion emission control devices on construction vehicles and equipment used by contractor, and encouraging shutdown of motorized equipment not actually in use.
- C. Trash burning not permitted on construction site.
- D. If temporary heating devices are necessary for protection of work, they shall not cause air pollution.

1.06 PROTECTION from FUEL and SOLVENTS

- A. All required material must be submitted prior to the precon meeting. No equipment may be delivered to the site without approval of submittals.
- B. The owner reserves the right to restrict equipment location.
- C. Disposal of waste fluids shall be in conformance with federal, state, and local laws and regulations.

1.07 USE of CHEMICALS

- A. Chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of U.S. EPA, U.S. Department of Agriculture, state, or other applicable regulatory agency.
- B. Use of such chemicals and disposal of residues shall be in conformance with manufacturer's written instructions and applicable regulatory requirements.

1.08 NOISE CONTROL

- A. Conduct operations to cause least annoyance to residents in vicinity of work, and comply with applicable local ordinances.
- B. Equip compressors, hoists, and other apparatus with mechanical devices necessary to minimize noise and dust. Equip compressors with silencers on intake lines.
- C. Equip gasoline or oil-operated equipment with silencers or mufflers on intake and exhaust lines.
- D. Route vehicles carrying materials over such streets as will cause least annoyance to public and do not operate on public streets between hours of 6:00 P.M. and 7:00 A.M., or on Saturdays, Sundays, or legal holidays unless approved by owner.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 HAZARDOUS MATERIALS PROJECT PROCEDURES

A. Applicable Regulations:

1. RCRA, 1976 – Resource Conservation and Recovery Act: This federal statute regulates generation, transportation, treatment, storage and disposal of hazardous wastes nationally.
2. Act 64, 1979 – Michigan’s Hazardous Waste Management Act: This statute regulates generation, transportation, treatment, storage, and disposal of hazardous wastes.
3. Act 641 as amended 1990 – Michigan’s Solid Waste Act: This statute regulates generation, transportation, treatment, storage and disposal of solid wastes.

B. Use the Uniform Hazardous Waste Manifest (shipping paper) to use an off-site hazardous waste disposal facility.

C. Federal, State and local laws and regulations may apply to the storage, handling and disposal of hazardous materials and wastes. The list below includes the regulations which are most frequently encountered:

<u>Topic</u>	<u>Agency and Telephone Number</u>
Small quantity hazardous waste management, including hazardous waste stored in tanks	Hazardous Waste Division, DEQ (517) 373-2730 in Lansing, or District Office Certified County Health Department
Disposal of heavy metals into municipal sanitary sewers	Contact the superintendent of your wastewater treatment plant for permission
Hazard Communication Standards (for chemical in the workplace)	Occupational Health Division, Michigan Department of Consumer and Industrial Services (517) 373-1410
Burning of waste oil and other discharges to the air	Air Quality Division, DEQ (517) 322-1333 in Lansing, or District Office
Local fire prevention regulations and codes (including chemical storage requirements)	Local fire chief or fire marshal

D. Department of Environmental Quality
Hazardous Waste Division
Compliance Section District Offices

Jackson District Office
301 E. Louis Glick Hwy.
Jackson, MI 49201
(517) 780-7690
(517) 780-7855 (fax)

END OF SECTION

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SECTION 01600 - GENERAL EQUIPMENT STIPULATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. These General Equipment Stipulations apply, in general, to all equipment provided under other Specification Sections. They shall supplement the detailed equipment specifications, but in cases of conflict the equipment specifications shall govern.
- B. Related Sections: Electric and DC-driven motors are specified in Section 16220.

1.02 OPERATION AND MAINTENANCE

Refer to section 01781

1.03 QUALITY ASSURANCE

- A. Compliance with OSHA: All equipment provided under this Contract shall meet all the requirements of the Federal and/or State Occupational Safety and Health Acts. Each equipment supplier shall submit to ENGINEER certification that the equipment furnished is in compliance with OSHA.
- B. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by CONTRACTOR.

1.04 SHIPPING AND HANDLING EQUIPMENT

- A. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment and handling.

1.05 SPARE MATERIALS

- A. All V-belt driven equipment shall be furnished with a complete set of spare belts per each piece of equipment. When two or more similar pieces of equipment are furnished, replacement belt assemblies shall be furnished for every other drive assembly.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Anchor Bolts: Anchor bolts, nuts, and washers shall be hot-dipped galvanized in conformity with ASTM A 385 and be supplied with sleeves.
- B. Shop Painting:
 - 1. Non-submerged Applications: Tnemec Series 37H, Chem-Prime.
 - 2. Submerged, Non-potable Applications: Tnemec Series 66, Hi-Build Epoxoline.
 - 3. Submerged, Potable Applications: Tnemec Series 139, Pota-Pox II.
 - 4. Rust preventive compound shall be:
 - a. Dearborn Chemical, No-Ox-ID2W.
 - b. Houghton, Rust Veto 344.
 - c. Rust-Oleum R-9.

2.02 MANUFACTURED UNITS

- A. Wall and Slab Sleeves and Castings: Where water- or gas-tightness is essential and at other locations where indicated, wall castings and sleeves shall be provided with an intermediate flange located approximately at the center of the wall or slab.
 - 1. All sleeves and casting shall be flush with walls and underside of slabs but shall extend 2 inches above finished floors.

2.03 COMPONENTS

- A. Lubrication: Equipment shall be adequately lubricated by systems which require attention no more often than weekly during continuous operation. Lubrication system shall not require attention during start-up or shutdown and shall not waste lubricants.
 - 1. Lubrication point shall be easily accessible with all points of application provided with standard fittings for greasing or placing oil.
 - 2. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity for all consumption prior to completion of required testing and acceptance of equipment by OWNER.
- B. Safety Guards: All belt or chain drives, fan blades, couplings, vertical or horizontal drive shafts, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 gauge or heavier galvanized or aluminum-clad sheet steel or 1/2-inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal and painted safety yellow.
 - 1. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be hot-dipped galvanized.
 - 2. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.
- C. Anchor Bolts: All necessary anchor bolts shall be provided as per the manufacturer's recommendations for size, strength, and location and shall meet the requirements of Standard Details on Drawings. Substantial templates and working drawings for installation shall be provided. Two nuts shall be furnished.

1. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.
- D. Seals: Mercury seals will not be acceptable.
- E. Bearings: All antifriction bearings shall be designed per the Anti-Friction Bearing Manufacturers Association (AFBMA) recommendations with a rating life of B-10, 30,000 hours.
- F. Equipment Bases: A cast iron or welded steel baseplate shall be provided for all equipment and motor assemblies. Each baseplate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have a threaded drain connection. Bases shall be fully braced to withstand shock loads and resist buckling. Necessary safety guard mounting shall be provided as part of the equipment base.
- G. Motor Starters and Control Panels: Motor starters 480 volt or less shall be size one or larger and have 120 volt AC contactor coils. All control circuits and indicating lights associated with the starter shall be 120 volt. The control transformer shall be sized to have 100 VA minimum spare capacity for future use. A terminal strip shall be provided for all control wires entering the starter with spare terminals for future use. The terminal strip and wires shall be identified. One spare normally open auxiliary starter contact, wired to the terminal strip, shall be provided for future use. Indicating lights shall be 120 volt, oiltight, push-to-test type. Explosion-proof units shall meet NEC Class I, Division I, Group D requirements.
1. Provide equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction, such as NEMA 4, 4X, 7, or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.

2.04 FABRICATION

- A. Shop Painting: All iron and steel surfaces shall be protected by suitable paint or coatings applied in the shop or at point of fabrication. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment.
1. All iron and steel surfaces which will be totally or partially submerged or located in a continuously or intermittently moist atmosphere during normal operation shall be shop blast cleaned to a near-white finish, removing all dirt, rust-scale, and foreign matter by any of the recommended methods outlined in the Steel Structures Painting Council Specification SP-10.
 2. The cleaned surfaces shall be shop primed before any rust bloom forms. All other exposed surface shall be properly filed, scraped, sanded, etched, brushed, sandblasted, and/or cleaned to provide surfaces free from dirt, loose crystals, rust, scale, oil, and grease and shop primed.
 3. Shop primed surfaces shall be painted with one or more coats of a primer which meets the requirements of this Section and is compatible with the finish painting system specified in Section 09900. Minimum shop coat thickness shall be 1.5 dry mills.
- B. Electric motors, speed reducers, starters, pumps, motor control centers, control panels, and other self-contained or enclosed components shall be shop finished with 2 coats of an enamel paint as per manufacturer's recommendations.

- C. Where specified, steel and iron surfaces shall be hot-dipped galvanized in conformity with ASTM A 153 and A 385.
- D. Machined, polished, and nonferrous surfaces which are not to be painted or galvanized shall be coated with rust preventive compound.

PART 3 - EXECUTION

3.01 EQUIPMENT BASES

- A. The baseplate shall be installed on a concrete base. Baseplates shall be anchored to the concrete base with suitable anchor bolts and grouted in place.

3.02 WALL AND SLAB SLEEVES AND CASTINGS

- A. Unless otherwise shown on Drawings or specified, at all points where pipes or conduit pass through walls, slabs or roofs, suitable sleeves or castings shall be furnished and installed. Sleeves and castings shall not be painted in areas to be embedded in the concrete. All loose rust, scale, grease, or oil shall be removed prior to pouring the concrete.
- B. Unless otherwise shown or approved by ENGINEER, the space between the pipe and the sleeve shall be caulked. All ground buried and water or gas retaining wall or slab sleeves or castings shall be mechanical joint.

3.03 EQUIPMENT INSTALLATION CHECK

- A. Refer to Section 01810.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.

3.04 OPERATION AND MAINTENANCE TRAINING

- A. Refer to Section 01820.

END OF SECTION

SECTION 01770 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for Contract closeout including, but not limited to:
 - 1. Warranties and Bonds.
 - 2. Requirements for Substantial Completion.
 - 3. Project record document submittal.
 - 4. Equipment acceptance.
 - 5. Operating and maintenance manual submittal.
 - 6. Final cleaning.
- B. Certifications and other commitments and agreements for continuing services to OWNER are specified elsewhere in the Contract Documents.

1.02 WARRANTY REQUIREMENTS

- A. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve CONTRACTOR of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with CONTRACTOR.
- B. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- C. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- D. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. CONTRACTOR is responsible for the cost of replacing or rebuilding defective Work regardless of whether OWNER has benefited from use of the Work through a portion of its anticipated useful service life.
- E. OWNER's Recourse: Written warranties made to OWNER are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which OWNER can enforce such other duties, obligations, rights, or remedies.
- F. Rejection of Warranties: OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

- G. OWNER reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.03 SUBSTANTIAL COMPLETION

- A. Substantial completion is defined in section 01110.
- B. Substantial completion shall not be achieved prior to successful completion of the operational demonstration as detailed in Section 01810.
- C. Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete. Include supporting documents for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price.
 - 2. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
 - 3. Advise OWNER of pending insurance changeover requirements.
 - 4. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
 - 5. Obtain and submit releases enabling OWNER unrestricted use of the Work and access to services and utilities; include occupancy permits, operating certificates, and similar releases.
 - 6. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
 - 7. Provide all required O&M, demonstration and training sessions.
- D. Inspection Procedures: On receipt of a request for inspection, ENGINEER will either proceed with inspection or advise CONTRACTOR of unfilled requirements.
 - 1. ENGINEER will prepare the Certificate of Substantial Completion following inspection, or advise CONTRACTOR of construction that must be completed or corrected before the certificate will be issued.
 - 2. ENGINEER will repeat inspection when requested and assured that the Work has been substantially completed.
 - 3. Results of the completed inspection will form the basis of requirements for final acceptance.
- E. The warranty period for specific portions of the Work will begin on the date established on Component Acceptance Form or at such other date as agreed by OWNER, ENGINEER, and CONTRACTOR.

1.04 FINAL ACCEPTANCE

- A. Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
 - 1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 - 2. Submit an updated final statement, accounting for final additional changes to the Contract Price.

3. Submit a copy of ENGINEER's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by ENGINEER.
 4. Submit consent of surety to final payment.
 5. Submit a final liquidated damages settlement statement.
 6. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 7. Submit record drawings, maintenance manuals, final Project photographs, damage or settlement survey, property survey, and similar final record information.
 8. Deliver tools, spare parts, extra stock, and similar items.
 9. Make final changeover of permanent locks and transmit keys to OWNER. Advise OWNER's personnel of changeover in security provisions.
 10. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
 11. Complete final cleaning
 12. Meet all other conditions of the Contract.
- B. Reinspection Procedure: ENGINEER will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to ENGINEER.
1. Upon completion of reinspection, ENGINEER will prepare a certificate of final acceptance as shown at the end of this Section, or advise CONTRACTOR of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, reinspection will be repeated.

1.05 SUBMITTALS

- A. Submit written warranties to ENGINEER prior to the date certified for Substantial Completion. Warranties shall be provided in a single binder. If ENGINEER's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of ENGINEER.
- B. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.

1.06 RECORD DOCUMENT SUBMITTALS

- A. Record Drawings:
1. Refer to Section 01780.
- B. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and submittals in connection with actual performance of the Work.
1. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to ENGINEER for OWNER's records.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of other Sections, operation and maintenance manuals for items included under this Section.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 COMPONENT ACCEPTANCE

- A. Component Acceptance Certificate: For each item of equipment incorporated into the Project, ENGINEER will issue a Component Acceptance Certificate as shown in Section 00625.
- B. The certificate will certify that the equipment installation is complete, that manufacturer-provided inspection and start-up services and training have taken place, and that OWNER has beneficial use of the equipment.
- C. The data on the Component Acceptance Certificate may be used to establish the time of beginning for the warranty period for that piece of equipment, if OWNER begins to use it at that time.

3.02 FINAL CLEANING

- A. General cleaning during construction is required by the General Conditions and included in Sections 01310 and 01500.
- B. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- C. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion as shown at the end of this Section.
 - 1. Remove labels that are not permanent labels.
 - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean.
 - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
 - 5. Clean Site, including landscape development areas, of rubbish, litter, and foreign substances. Sweep paved areas broom clean; remove stains, spills, and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth even-textured surface.
 - 6. Sweep paved areas broom clean; remove stains, spills, and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth even-textured surface.

7. The site of the work shall be rehabilitated or developed in accordance with other sections of the Specifications. In the absence of any portion of these requirements, the CONTRACTOR shall completely rehabilitate the site to a condition and appearance equal or superior to that which existed just prior to construction, except for those items whose permanent removal or relocation was required in the Contract Documents or ordered by the OWNER.
- D. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.
 - E. Comply with regulations of authorities having jurisdiction and safety standards for cleaning.
 1. Do not burn waste materials. Do not bury debris or excess materials on OWNER's property.
 2. Do not discharge volatile, harmful, or dangerous materials into drainage systems.
 3. Remove waste materials from Site and dispose of in a lawful manner.
 - F. Where extra materials of value remaining after completion of associated Work have become OWNER's property, arrange for disposition of these materials as directed.

END OF SECTION

CERTIFICATE OF COMPONENT ACCEPTANCE

Contract _____

Contract No. _____

Date Issued: _____

Specification Section No. _____

Equipment Item: _____

Manufacturer: _____

Manufacturer's Representative: _____ Phone _____

Address: _____

The representative named above hereby approves the equipment installation, and certifies that:

1. The equipment has been properly installed and lubricated.
2. The equipment is in accurate alignment.
3. The equipment is free from any undue stress imposed by connecting piping or anchor bolts.
4. The equipment has been operated under *full load conditions* and that it operated satisfactorily to ENGINEER.
5. OWNER's Representative has been instructed in the proper lubrication and operation of the equipment.
6. OWNER's Representative has been given a copy of all test data recorded during the installation check including speed, noise level, vibration, etc. (If no data was taken, so state below.)

The manufacturer's representative takes no exceptions to the above unless such exceptions are written below:
(Continue on another sheet if required.)

_____ Manufacturer's Representative	_____ Date	_____ Signature
Witnesses:		
_____ Contractor's Representative	_____ Date	_____ Signature
_____ Emily Schlanderer		
_____ Owner's Representative (Engineer)	_____ Date	_____ Signature
_____ Owner	_____ Date	_____ Signature

CERTIFICATE OF SUBSTANTIAL COMPLETION

Contract _____
Contract No. _____
Date Issued: _____
OWNER _____
CONTRACTOR _____

This Certificate of Substantial Completion applies to all Work under the Contract.

The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, and that Work is hereby declared to be substantially complete in accordance with the Contract Documents on

DATE OF SUBSTANTIAL COMPLETION

A tentative punch list of items to be completed or corrected is attached hereto as Attachment No. A. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of CONTRACTOR to complete all the Work in accordance with the Contract Documents. The items in the tentative list shall be completed or corrected by CONTRACTOR by _____, _____.

The responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, heat, utilities, insurance and warranties and guarantees pending final payment shall be as follows:

OWNER: Shall perform and/or maintain insurances, if any, in accordance with Article 5 of the General Conditions, and allow CONTRACTOR reasonable access to complete or correct items on the tentative list. Additional responsibilities are:

CONTRACTOR: Shall perform and/or maintain Site security, temporary facilities, Bonds and insurances in accordance with Article 5 of the General Conditions, and protect the Work. Additional responsibilities are:

The following documents are attached to and made a part of this Certificate:

Attachment A: Tentative Punch List of Items to be completed prior to Final Payment (Pages 1 to 2, inclusive).

This certificate does not constitute an acceptance of Work not in accordance with the Contract Documents nor is it a release of CONTRACTOR's obligation to complete the Work in accordance with the Contract Documents.

Executed by ENGINEER on _____
Date

ENGINEER

By: _____
(Authorized Signature)

CONTRACTOR accepts this Certificate of Substantial Completion on _____
Date

CONTRACTOR

By: _____
(Authorized Signature)

CERTIFICATE OF FINAL COMPLETION

Contract _____
Contract No. _____
Date Issued: _____
OWNER _____
CONTRACTOR _____

This Certificate of Final Completion applies to all Work under the Contract Documents or to the following specified parts thereof:

The Work to which this Certificate applies has been inspected by authorized representatives of OWNER, CONTRACTOR and ENGINEER, and that Work is hereby declared to be finally complete in accordance with the Contract Documents on

DATE OF FINAL COMPLETION

CONTRACTOR's general warranty and guarantee period commences on ____ __ and terminates on ____ ____.

This certificate does not constitute an acceptance of Work not in accordance with the Contract Documents nor is it a release of CONTRACTOR's obligation to correct defective Work in accordance with the General Conditions of the Contract Documents.

Executed by ENGINEER on _____
Date

ENGINEER

By: _____
(Authorized Signature)

CONTRACTOR accepts this Certificate of Final Completion on _____
Date

CONTRACTOR

By: _____
(Authorized Signature)

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SECTION 01780 - CLOSEOUT SUBMITTALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Project record documents.
- B. Spare parts and maintenance products.
- C. Preventative maintenance instructions
- D. Warranties and bonds

1.02 PROJECT RECORD DOCUMENTS

- A. Maintain on site one clean, undamaged set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by OWNER.
- C. Store record documents separate from documents used for construction.
- D. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish floor datum.
 - 2. Measured horizontal and vertical locations of all underground and exposed utilities and appurtenances, including thrust blocks, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
 - 4. Measured horizontal and vertical locations of all concealed and exposed electrical conduits. Conduits shall be shown in plain view on the record drawings with their size and contents indicated.
 - 5. Field changes of dimension and detail.
 - 6. Details not on original Contract drawings.
- F. Indicate the date of revisions to the plans in the appropriate box on the plans.
- G. Submit documents to ENGINEER prior to Final Application for Payment.

1.03 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Provide spare parts, maintenance, and extra products in quantities specified in individual specification sections. This may include, but is not limited to the topics in Table 01780.
- B. All wearable items should be supplied to provide at least two years of operation and maintenance.

01780-A, Spare Parts Table

Equipment	Specification Section	Parts
Painting	0990	Extra stock
Instrumentation Spare Parts	13491	1 year supply
Computer Room Air Conditioner	15734	Air Filter, Belts
Power Ventilators	15383	Belts, filters
Standby Natural Gas Generator Sets	16231	Oil, Oil Filter, Air Filter, antifreeze
Panelboards	16440	Circuit breakers
Motor Control Center	16421	Circuit Breakers, Size 2 Starter
Variable Frequency Drives	16480	Fuses, Relays, Timers, Overloads

- C. Deliver to project site and place in location as directed; obtain signed receipt from the City prior to final payment.
- D. Cover and protect parts from moisture.
- E. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers: wooded, cardboard, or palletized.
- F. Stencil on containers:
 1. Manufacturer/supplier name.
 2. Unit name.
 3. Spare part name.
 4. Manufacturer catalogue number.
 5. Other identifying information.
 6. Precautionary information.

1.04 PREVENTATIVE MAINTENANCE SCHEDULE

- A. Submit, in addition to the operation and maintenance data, an equipment maintenance schedule for each piece of equipment. Include the following:
 1. Identity of Equipment.
 2. Routine manufacturer recommended preventative maintenance
 - a. Daily
 - b. Weekly
 - c. Monthly

- d. Quarterly
- e. Semi-Annually
- f. Annually

B. Equipment maintenance schedule shall be in a clear, tabular format and the same format for all equipment. Four (4) copies of each shall be provided.

1.05 WARRANTIES AND BONDS

- A. Warranties and bond requirements are covered in the General Conditions except where modified in the technical specifications.
- B. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers. All warranties shall begin at the Date of Final Payment, or at the date of acceptance by the OWNER, whichever is later. Table 01780-B is a guide for warranties in this contract but is not intended to replace any warranty requirements listed in individual sections of this project manual.

01780-B, Warranty Table

Equipment	Specification Section	Warranty Length
Restoration Work	02805	1 year
Roof Accessories	07720	20 years
Special Warranty for Glazing/Glass	08800	10 years
Fire Extinguishers (including inspection and recharge at end of first year)	10522	1 year
Metal Building Systems - finishes	13341	20 years
Metal Building Systems – weather-tightness	13341	20 years
Radiant Heaters	15546	Burner 5 years Tubes 3 years Heater Controls 1 year
Breechings, Chimneys and Stacks	15550	10 years
Computer-room Air Conditioners	15734	5 years
Standby Natural Gas Generators	16231	2 years
Transient Voltage Surge Suppressors	16280	5 years
Variable Frequency Drives	16480	2 years
Emergency Fixture Battery	16510	5 years

- C. Execute and assemble all transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers into one binder.
- D. Verify that documents are in proper form, contain full information, and are notarized. Manufacturer’s warranties shall be in the name of the Owner.

- E. Provide Table of Contents and assemble in three-ring binders with durable plastic cover.
- F. Submit prior to Final Application for Payment.
- G. Time of submittals:
 - 1. Make warranty submittal within ten days after Date of Substantial Completion, prior to Final Application for Payment.
 - 2. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing the date of acceptance as the beginning of the warranty or bond period.
- H. Rejection of Warranties: OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01781 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Operation and maintenance data/manuals.

1.02 SUBMITTALS

- A. Submit operations and maintenance data for all equipment.
- B. Quantity Required and Timing of Submittals:
 - 1. Preliminary Submittal:
 - a. Printed Copies: 4 copies, exclusive of copies required by CONTRACTOR.
 - b. Electronic Copies: 1 copy.
 - c. Submit to ENGINEER by the earlier of: ninety days following approval of Shop Drawings and product data submittals, or thirty days prior to starting training of operations and maintenance personnel, or ten days prior to field quality control testing at the Site.
 - d. Furnish preliminary operation and maintenance data submittal in acceptable form and content, as determined by ENGINEER, before associated materials and equipment will be eligible for payment.
 - 2. Final Submittal: Provide final submittal prior to Substantial Completion, unless submittal is specified as required prior to an interim Milestone.
 - a. Printed Copies: 4 copies.
 - b. Electronic Copies (Searchable PDF): 2 copies

1.03 OPERATION AND MAINTENANCE DATA/MANUALS

- A. Binding and Cover:
 - 1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be minimum one-inch wide and maximum of three-inch wide. Binders for each copy of each volume shall be identical.
 - 2. Binders shall be locking three-ring/"D"-ring type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front of each volume.
 - 3. Do not overfill binders.
 - 4. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.
 - 5. Provide the following information on cover of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume __ of __", with appropriate volume-designating numbers filled in.

- d. Name of Project and, if applicable, Contract name and number.
- e. Name of building or structure, as applicable.
6. Provide the following information on spine of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume __ of __", with appropriate volume-designating numbers filled in.
 - d. Project name and building or structure name.
7. The manuals' cover sheets and spines shall all be matching. The CONTRACTOR shall prepare a template for use by the various subcontractors.

B. Pages:

1. Print pages in manual on 30-pound (minimum) paper, 8.5 inches by 11 inches in size.
2. Provide each page with binding margin at least one inch wide. Punch each page with holes suitable for the associated binding.

C. Drawings:

1. Bind into the manual drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing specified for pages.
2. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Include no more than three drawing sheets per pocket.

D. Copy Quality and Document Clarity:

1. Contents shall be original-quality copies. Documents in the manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals that contain copies that are unclear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable. Faxed copies are unacceptable.
2. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content. Using highlighters to so indicate options furnished is unacceptable.

E. Organization:

1. Table of Contents:
 - a. Provide table of contents in each volume of each operations and maintenance manual.
 - b. In table of contents and at least once in each chapter or section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using material or equipment model or catalog designations for identification is unacceptable.
2. Use dividers and labeled index tabs between equipment items and between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

3. Each equipment item shall have an individual cover sheet with the following information:
 - a. Name or type of material or equipment.
 - b. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 - c. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 - d. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
 - e. City Equipment Number if applicable.

1.04 ELECTRONIC REQUIREMENTS

- A. Electronic Copies of Operation and Maintenance Manuals:
 1. Each electronic copy shall include all information included in printed copy.
 2. Submit each electronic copy on a separate compact disc (CD), unless another electronic data transfer method or format is acceptable to ENGINEER.
 3. File Format:
 - a. The O&M Manuals will be placed into the OWNER's Content Management System. All electronic files shall be compatible with this system.
 - b. Files shall be in "portable document format (PDF)". Files shall be entirely electronically searchable and created from the original document. Scanned/Image PDF's will not be accepted.
 - c. Submit separate file for each separate document in the printed copy.
 - d. Within each file, provide bookmarks for the following:
 - 1) Each chapter and subsection listed in the printed copy document's table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix.
 4. Also provide drawings and figures in one of the following formats: ".bmp", ".tif", ".jpg", or ".gif". Submit files in a separate directory on the CD.
 5. Technical drawings will be provided in both AutoDesk DWG format and PDF format.

1.05 CONTENT

- A. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
- B. Submit written explanations of all safety considerations relating to operation and maintenance procedures.

- C. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
1. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
 2. Recommended schedule for each preventive maintenance task.
 3. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
 4. Table of alternative lubricants.
 5. Troubleshooting instructions.
 6. List of required maintenance tools and equipment.
- D. Complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
1. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 2. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 3. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
 4. For each part or piece include the following information:
 - a. Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
 - b. Part name or description.
 - c. Manufacturer's part number.
 - d. Quantity of each part used in each assembly.
 - e. Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.
- E. Complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.
- F. Manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
- G. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment.

Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.

- H. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
- I. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
- J. Programmable Logic Controllers: If programmable logic controllers are furnished
 1. Submit complete logic listings in one consistent format.
 2. Format Requirements:
 - a. For ladder diagram logic, include complete cross-referencing of all logic elements. Annotate all elements with clearly understandable tags or descriptive labels.
 - b. For function block diagram, label each function block with understandable tags or descriptive labels. Describe purpose and action of each function block.
 - c. For sequential function chart, include extensive comments for each step to describe program step function.
 - d. For instruction list and structured text, include extensive comments for each program line to describe program line function.
 3. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
 4. Submit complete manufacturer's programming manuals.
- K. Copy of warranty bond and service contract as applicable.
- L. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

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SECTION 01810 - COMMISSIONING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Commissioning Plan
- B. Functional Completion Testing
- C. Startup
- D. Commissioning
- E. Performance Testing
- F. Operational Demonstration

1.02 DEFINITIONS

- A. Commissioning: Commissioning is the series of activities or processes necessary to ensure that equipment and systems are designed, installed, functionally tested, started up and capable of being operated and maintained to perform in conformity with the design intent for the facility improvements. Commissioning includes, but is not limited to factory testing, field testing, dry testing, wet testing with plant water, performance testing, Manufacturer's checkout, and operational demonstration.
- B. Factory Testing: Factory testing is performance testing, operation testing, or documentation verification conducted in the production facility, specialized test facility, or by the equipment manufacturer or supplier. Such testing shall conform to the requirements of the individual sections of the Contract Documents. "Witnessed" factory testing shall mean that the testing is witnessed by the OWNER or his designated representative.
- C. Field Testing: Field testing is performance testing, operation testing, or documentation verification conducted in the field after installation, to provide comparison with the results obtained in the factory testing.
- D. Dry Testing: Dry testing is performed by the CONTRACTOR without introducing either process material or other test material into the component, system, or unit process.
- E. Wet Testing: Wet testing is testing performed by the CONTRACTOR utilizing plant water in the component, system, or unit process. Tankage shall be filled with plant water to operating level.
- F. Performance Testing: Performance Testing is testing performed by the CONTRACTOR to demonstrate the specified throughput of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees.

- G. **Manufacturer's Checkout:** Manufacturer's checkout shall be performed directly by the manufacturer. Checkout by the local equipment representative or salesman is not permitted. Checkout shall include, but not be limited to, wiring and power supply, installation, tolerances, clearances, rotation, etc.
- H. **Startup:** Startup shall be defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or systems with other equipment that is a part of the Facility. Startup shall be performed by the CONTRACTOR, manufacturer, and local equipment representative.
- I. **System:** A "system" includes all required items of equipment, devices, and appurtenances connected so that their operation or function compliments, protects, or controls the operation or function of the others.
- J. **Operational Demonstration:** A commissioning activity performed by the CONTRACTOR wherein the CONTRACTOR operates and maintains a fully functional component system, unit process for a period of time after stable operation has been achieved. For purposes of this project, the period of time shall be 30 days, unless noted otherwise for specific pieces of equipment.
- K. **Commissioning Plan:** The Commissioning Plan incorporates all aspects of functional completion testing, startup, commissioning, performance testing, training, and reliability tests to ensure the facility operates properly and meets design intent and performance.

1.03 QUALITY ASSURANCE

- A. **CONTRACTOR shall appoint a Performance Testing Manager who shall:**
 - 1. Manage, coordinate, and supervise CONTRACTOR's start-up, testing, and commissioning activities including but not limited to field testing, dry testing, wet testing with plant water, performance testing with process liquids and solids, manufacturer's checkout and the Operational Demonstration.
 - 2. Assist in coordinating and documenting Site quality control Work specified in individual Specification Sections.
 - 3. Prepare, or review and approve, all submittals for the Work under this Section and related Work contained within the Contract Documents.
 - 4. Coordinate activities of subcontractors, manufacturers and suppliers relative to the start-up, testing, and commissioning activities.
- B. **Performance Testing Manager shall be at the Site a minimum of eight hours per day during all testing and be available at all times, 24 hours per day, seven days per week to perform these duties.**
- C. **Performance Testing Manager shall supervise the CONTRACTOR's Operations ENGINEER and Operations Specialists who shall be dedicated to the start-up, testing, and commissioning Work.**

1.04 SUBMITTALS

- A. **Field Installation Reports – Submit reports by Manufacturer's Representative in accordance with the Contract Documents.**

- B. Detailed Commissioning Plan – Submit detailed commissioning plan in accordance with the Contract Documents 90 days in advance of starting, testing and placing equipment into operation.
- C. Start up and Testing Documentation: CONTRACTOR shall prepare and submit all documentation for review and approval. The documentation shall include, but not be limited to, the following:
 - 1. Develop blank testing forms specific to each item of equipment or system to be filled out during start-up and testing.
 - a. All forms must be approved by ENGINEER and OWNER prior to use.
 - b. Pump testing form shall at a minimum include VFD speed, flow, suction pressure, discharge pressure, amperage, voltage, and kW.
 - 2. Field testing plans, dry testing plans and wet testing plans that describe in detail the proposed testing procedures that will show the equipment and systems performance is in accordance with the requirements of the Contract Documents.
 - 3. Field testing, dry testing and wet testing reports including recorded test data, performance tolerances, observations, measurements taken, problems and modifications or corrective action taken for the equipment and systems to perform in accordance with the Contract Documents.
 - 4. Certification by the preparer that he/she is the person responsible for the data, and that the data is authentic and accurate.
 - 5. Certification by the CONTRACTOR or equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance, and that the equipment or unit process systems are suitable for Operational Demonstration.
- D. Develop performance testing plans and operational demonstration plans describing in detail, coordinated, sequential testing and demonstration of each system to be tested. Performance testing plan and operational demonstration plan shall be specific to the system or equipment item to be tested, and shall identify by specific equipment or tag number each device or control station to be manipulated or observed during testing, and specific results to be observed or obtained. Subcontractors and suppliers shall be present during testing, and for the planned testing duration. Performance testing plans and operational demonstration plans shall include:
 - 1. Summary of results of field testing, dry testing and wet testing.
 - 2. Calibration of all field instruments and control devices.
 - 3. Description of and information on temporary systems, equipment, and devices proposed for performance Testing and Operational Demonstrations, including calibration data for temporary instrumentation and controls.
 - 4. Description of data reduction required, if any, and proposed time between collection of data and submittal of results to ENGINEER.
 - 5. Summary of criteria for acceptance of test results. Summary shall include performance tolerances (if any) included in the Contract Documents. Where performance tolerances are not included in the Contract Documents, testing plans shall include proposed performance tolerances for approval by OWNER and ENGINEER.

6. Following ENGINEER's approval of performance testing plans and operational demonstration plans, CONTRACTOR shall reproduce performance testing and operational demonstration plans in sufficient quantity for CONTRACTOR'S purposes plus five copies to ENGINEER and five copies to OWNER. Do not start performance testing or operational demonstrations until required quantity of approved plans are provided.
- E. Testing Schedule: Provide a testing schedule that sets forth the planned sequence for performance testing and operational demonstration work. Testing schedule shall be part of the Progress Schedule and shall conform to requirements for Progress Schedule.
1. Detail the equipment and systems to be tested.
 2. Show planned start date, duration, and completion of each test.
 3. Testing schedule shall be submitted no later than eight weeks in advance of the date performance testing and operational demonstrations are to begin. ENGINEER will not witness performance testing and operational demonstration work until test schedule is accepted by ENGINEER.
 4. Testing schedule shall be updated weekly and resubmitted to ENGINEER. Updates shall indicate actual dates of performance testing and operational demonstration Work, indicating equipment, systems and treatment train for which testing is in progress, and that are satisfactorily completed in accordance with the Contract Documents.
- F. Following a successful Operational Demonstration, a summary report containing the following, at a minimum, shall be provided by the CONTRACTOR:
1. Equipment, systems and plant treatment trains started-up and commissioned.
 2. Start-up and commissioning dates.
 3. Equipment, systems and performance criteria tested, clearly showing requirements and field data that verifies requirements were met.
 4. Names of witnesses for start-up and commissioning.
 5. Any repairs, corrections, or modifications required for the equipment or unit process systems to successfully complete start-up and commissioning.
 6. Loop diagrams accurately depicting the installed condition of instrumentation and controls.
 7. Any other important Operational Demonstration information.
 8. Report Appendix containing the following, as a minimum:
 - a. A summary of all testing data used and calculations, including source, formulas with all terms defined.
 - b. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.
 - c. Production and operational data.
 - d. Calibration sheets for equipment.
 - e. Copies of calibration records for instrumentation.

1.05 COMMISSIONING PLAN

- A. The CONTRACTOR shall be responsible for preparing, coordinating, and executing the Plan.
1. The CONTRACTOR shall use the resources of the equipment and unit process systems suppliers in this work, particularly for specific equipment and unit process systems.
 2. An initial draft Plan for the Facility shall be completed and submitted by the CONTRACTOR to the ENGINEER for review at least 90 days prior to the expected commencement of commissioning. The ENGINEER will require 45 days to review the submittal and return with any exceptions noted. The CONTRACTOR shall incorporate

the ENGINEER's comments into the revised Plan within 30 days of receiving comments, and reissue the Plan to the ENGINEER and OWNER.

- B. The CONTRACTOR shall provide a dedicated field staff to support the Plan activities. A full-time Startup Manager shall be responsible for day to day activities and shall be the primary contact with the ENGINEER regarding Plan activities. Support staff shall include but not be limited to designated mechanical, electrical and instrumentation and control ENGINEERs and technicians, and operating staff.
 - 1. The CONTRACTOR may require assistance from the OWNER's operating and maintenance staff in commissioning and performance testing activities specified herein. Activities requiring OWNER's staff shall be specifically noted in the Plan.
- C. The Plan shall define:
 - 1. A chronological schedule of all testing and inspection activities.
 - 2. A checklist of all inspection and testing activities broken down by location, discipline, system, and device or item.
 - 3. All blank forms proposed by the CONTRACTOR for verification or recording of the functional completion testing, startup, commissioning and performance testing.
 - 4. An index which cross references the forms to their intended application(s).
 - 5. A list of all supplier certifications, including those required by the applicable technical specifications. Provisions shall also be included for retesting, in the event it is required.
 - 6. A list of participants in functional completion testing, startup, commissioning, and performance testing.
 - 7. A list of special test equipment required for functional completion testing, startup, commissioning, and performance testing.
 - 8. Sources of the test media (water, power, air.) for functional completion testing.
 - 9. The proposed method of delivery of the media to the equipment to be tested during functional completion testing, startup, commissioning, and performance testing.
 - 10. Temporary or interim connections for the sequencing of multiple units during functional completion testing, startup, commissioning, and performance testing.
- D. The CONTRACTOR shall designate, in the Plan, a Testing and Checkout Coordinator, to coordinate and manage the activities defined in the Plan.

1.06 ROLES AND RESPONSIBILITIES

- A. CONTRACTOR shall provide competent, qualified representatives of material, equipment, and system manufacturers to provide services specified, including supervising installation, adjusting, starting-up, and testing of materials and equipment.
- B. The CONTRACTOR shall provide all outside services, materials, labor, supplies, test equipment and other items necessary to perform the Plant Testing, Startup and Commissioning specified herein. In addition, the CONTRACTOR shall arrange for and provide the participation or assistance of survey crews, quality control technicians, Supplier's representative(s), and required governmental agency representatives.
- C. The CONTRACTOR shall provide the services of the Supplier's representative(s) as follows:
 - 1. Assistance during installation as specified in Divisions 1 through 16 and as specified herein.
 - 2. Field Testing as specified in Divisions 1 through 16 and as specified herein.

3. Startup as specified in Divisions 1 through 16 and as specified herein.
 4. Commissioning as specified in Divisions 1 through 16 and as specified herein.
- D. The Supplier's representative's activities required by this Section are in addition to the requirements for vendor training and other services specified elsewhere in the Contract Documents. Timing for the performance of these services is to be defined in the CONTRACTORS Checkout Plan, specified herein, and shall not be concurrent.
- E. The ENGINEER will review and comment on the CONTRACTOR's deliverables, participate in the physical inspection activities, witness the shop and field testing, witness functional testing, maintain the permanent record of all testing results, and provide verification of conformance to the specifications. The ENGINEER's right to perform inspections, witness tests or monitor or assess the Work and activities does not relieve the CONTRACTOR of its obligation to comply with the requirements of the Contract Documents nor does it imply completion of the Work.

1.07 FUNCTIONAL COMPLETION TESTING

- A. Functional Completion Testing shall be completed as construction and installation of equipment is completed to demonstrate that the equipment is ready for equipment and systems startup.
- B. Functional Completion Testing shall be done in a coordinated manner based on the Plan prepared by the CONTRACTOR.
- C. The OWNER's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.
- D. Functional Completion Testing procedures and documentation forms shall be developed by the CONTRACTOR. The procedures shall include a listing of items inspected for Functional Completion Testing.
- E. If any equipment or unit process systems do not meet Functional Completion Testing requirements, it shall be the responsibility of the CONTRACTOR and/or equipment suppliers to make the necessary corrections or replacements and repeat the test.
- F. The equipment and unit process systems shall not be started up or put into service until the Functional Completion Testing is completed as evidenced by a completed Functional Completion Testing certificate for the equipment or subsystem.
- G. Modifications to the equipment and unit process systems required to meet Functional Completion Testing requirements shall be provided, and all retesting shall be performed at no additional cost to the OWNER.
- H. A Functional Completion Testing Certificate shall be prepared by the CONTRACTOR for each piece of equipment or system and submitted to the ENGINEER and OWNER for review.

1.08 COMMISSIONING

- A. All equipment shall be commissioned.
- B. Commissioning activities for the project shall not be initiated until the requirements of Startup are completed for the equipment or unit process systems.
- C. The requirements of this section shall be satisfactorily completed prior to beginning Performance Testing for equipment and unit process systems.
- D. Commissioning shall be used by the CONTRACTOR and equipment or unit process suppliers to adjust, fine tune, modify and prepare the equipment or system for continuous operation and Performance Testing.
- E. Equipment shall not be operated without the guidance of qualified personnel having the knowledge and experience necessary to conduct proper operation thereof and obtain valid results.
- F. All required adjustments, tests, operation checks, and Startup and Commissioning activities shall be provided by qualified personnel.
- G. CONTRACTOR shall be responsible for planning, supervising, and executing the Startup and Commissioning of the equipment and unit process systems with the assistance of equipment or unit process systems suppliers in accordance with the Plan.
- H. The CONTRACTOR shall be responsible for commissioning under the direction of its Startup Manager.
- I. The OWNER's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.
- J. For equipment or unit process systems that do not meet Commissioning requirements, it shall be the responsibility of the CONTRACTOR and/or equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Commissioning at no additional cost to the OWNER.
- K. The equipment or unit process systems shall not be Performance Tested or otherwise placed into service until Commissioning is completed as evidenced by a completed Commissioning certificate for the equipment or unit process systems.
- L. Commissioning Certificates for each piece of equipment or unit process shall be completed and submitted by the CONTRACTOR to the ENGINEER and OWNER for review.

1.09 PERFORMANCE TESTING AND OPERATIONAL DEMONSTRATION

- A. CONTRACTOR shall demonstrate the operation of all equipment and systems. CONTRACTOR shall provide all labor, materials, services, equipment, and incidentals required for Performance Testing and Operational Demonstrations as indicated in the Contract Documents. This Performance Testing and Operational Demonstrations shall be conducted, coordinated and recorded by the CONTRACTOR in accordance with the requirements

specified herein and in cooperation with the OWNER and ENGINEER. The pump station will not be considered Substantially Complete until the completion of the performance testing and operational demonstration.

- B. This Work is additional to any other installation, shop and factory testing, field testing, dry testing, wet testing, performance testing, balancing or adjustments required elsewhere in the Contract Documents.
- C. Conduct Performance Testing and Operational Demonstration testing for each item of process, mechanical, instrumentation and controls, plumbing, heating, ventilating, and air conditioning (HVAC); electrical systems and equipment, and other systems and equipment, to demonstrate compliance with the performance requirements of the Contract Documents.
- D. Objectives of Performance Testing and Operational Demonstrations are to:
 - 1. Demonstrate to the satisfaction of the OWNER and ENGINEER that structures, equipment and systems tested comply with all functional and performance requirements in the Contract Documents.
 - 2. Establish baseline operating conditions for OWNER's use in establishing standard operating procedures and preventative maintenance programs.
 - 3. The Performance Testing shall maintain conformance with performance tolerances for a period of not less than 7 days. If a testing failure occurs (whether process, mechanical, electrical, instrumentation) during the 7-day testing period, the malfunction shall be repaired, and the 7 day testing period shall restart.
 - 4. The Operational Demonstrations shall maintain conformance with the performance tolerances for a period of not less than 14 days. If a testing failure occurs (whether process, mechanical, electrical, instrumentation) during the 14- day testing period, the malfunction shall be repaired, and the 14-day testing period shall restart.
- E. Utilities and Consumables:
 - 1. CONTRACTOR shall provide the following: fuel, compressed air, temporary conduit, cable and wire, piping and appurtenances, and all other items and Work required for completing Performance Testing and Operational Demonstrations.
 - 2. OWNER will provide the electricity, chemicals, and plant water for the initial Performance Testing and Operational Demonstrations. CONTRACTOR shall provide all temporary electrical equipment, including but not limited to conduit and cable, piping and appurtenances required to convey electricity, chemicals, and plant water to the required testing location. If re-testing is required, cost of utilities and consumables furnished by OWNER for initial testing shall be paid by CONTRACTOR at OWNER's cost or standard rates, as applicable.
- F. Sequence: The following general sequence applies to Performance Testing and Operational Demonstrations:
 - 1. Furnish submittals required prior to Performance Testing, in accordance with the Contract Documents.
 - 2. Furnish acceptable operations and maintenance manuals in accordance with the Contract Documents.
 - 3. Complete the Work associated with starting and placing equipment and systems in operation in accordance with the Contract Documents.
 - 4. Training of operations and maintenance personnel in accordance with Section 01820, Demonstration and Training. Training must occur prior to the Operational Demonstration.

5. Proceed with Performance Testing in accordance with the Contract Documents, simulating the range of actual operating conditions to the greatest extent possible.
6. Complete site quality control Work specified in the Contract Documents for individual equipment items and systems. Field inspection, testing, and adjustments shall be signed off by approved representative of the Manufacturer, indicating that the equipment, components, systems, or unit processes meets the Manufacturer's requirements.
7. Following acceptance of the Performance Testing by the ENGINEER and OWNER, CONTRACTOR shall initiate a 14-day Operational Demonstrations, as described herein.
8. Successful completion of Operational Demonstration is part of the requirements to achieve Substantial Completion.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 STARTUP

- A. The CONTRACTOR's Performance Testing Manager and Manufacturer's Representative shall inspect equipment and systems prior to each start-up and verify their readiness for start-up. Conditions hazardous to equipment or personnel shall be corrected by the CONTRACTOR's Performance Testing Manager prior to start-up of equipment.
- B. Start-up operations shall not precede using temporary power or temporary instrumentation and control wiring. All electrical and control connections shall be permanent and complete, and all such electrical components and equipment fully functional.
- C. Use of repair parts during start-up operations shall not be permitted, except in such situations where the actual on-site verification of such repair parts' operability is specified.
- D. The CONTRACTOR's Performance Testing Manager shall verify that all initial copies of the maintenance and operating instructions have received, from the ENGINEER, an acceptable disposition as defined in Section 01330, Submittal Procedures, and the only outstanding item is the field verification of the maintenance and operating instructions.
- E. CONTRACTOR's Performance Testing Manager shall compare, and make adjustments to conform to; the Manufacturer's recommendations for the following minimum start up requirements:
 1. Motor Bearings and Shafting:
 - a. Inspect for cleanliness, and clean and remove foreign matter.
 - b. Verify alignment.
 - c. Replace defective bearings and those that operate rough or noisy.
 - d. Grease as necessary, in accordance with Manufacturer's recommendations.
 2. Motors:
 - a. Check each motor for comparison to amperage nameplate value.
 - b. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.

3. Pipe System:
 - a. Check glands and seals for cleanliness and adjustment before running pump.
 - d. Verify that piping system is free of dirt and scale before circulating liquid through system.
4. Valves:
 - a. Inspect manual and automatic control valves, and clean bonnets and stems.
 - b. Tighten packing glands to ensure no leakage, but allow valve stems to operate without galling.
 - c. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
 - d. Replace packing on valves that continue to leak.
 - e. Remove and repair bonnets that leak.
 - f. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".
 - g. Verify that control valve seats are free from foreign matter and are properly positioned for intended service.
5. Tighten flanges and other pipe joints after system has been placed in operation.
 - a. Replace gaskets that show signs of leakage after tightening.
6. Inspect all joints for leakage:
 - a. Promptly remake each joint that appears to be faulty; do not wait for rust or other corrosion to form.
 - b. Clean threads on both parts, and apply compound and remake joints.
7. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.
8. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.
9. Inspect fan wheels for clearance and balance.
10. Check each electrical control circuit to ensure that operation complies with the Contract Documents.
11. Inspect each pressure gauge, thermometer, and other instruments for calibration.
 - a. Replace items that are defaced, broken, or that read incorrectly.
12. Repair damaged insulation.
13. Vent gasses trapped in systems.
14. Verify that liquids are drained from all parts of gas or air systems.

A checklist showing the completed steps shall be submitted to OWNER upon successful start-up.

3.02 COMMISSIONING

- A. On successful completion of startup, the CONTRACTOR shall begin commissioning of the equipment and systems, wherein the equipment and systems are subjected to full operation. Adjustments shall be made as necessary and the equipment and system shall be optimized and brought into compliance with design criteria in preparation for performance testing and the Operational Demonstration specified within the Contract Documents.
- B. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Commissioning services for the new facility.
- C. The CONTRACTOR shall coordinate all Commissioning activities for equipment and systems in accordance with the accepted commissioning plan.

- D. Commissioning shall show that the equipment and unit process systems are capable of continuous operation using process liquids and solids, chemicals, and utilities; and that the flows, operating parameters and performance requirements have been demonstrated for a minimum of seven days of continuous operation, or the period required in the equipment specifications, whichever is longer.
- E. If the commissioning fails, the CONTRACTOR will be responsible for redoing the commissioning at no additional costs to the OWNER.
- F. Shutdowns that occur because of power outages, acts of God, or failure of support systems not part of this contract will not be a cause of failure of continuous operation during the Operational Demonstration.

3.03 PERFORMANCE TESTING AND OPERATIONAL DEMONSTRATION

- A. CONTRACTOR shall perform Operational Demonstration of the work. Unless otherwise specified, the Operational Demonstration shall be a continuous 14-day (336 hours) period during which the work is operated and maintained in a continuously on-line, fully functional process status.
- B. The Operational Demonstrations shall encompass the entire work, or the portion thereof designated for Substantial Completion. The Operational Demonstrations shall include all the equipment and systems.
- C. Filling, draining, cleaning, stabilizing, adjusting, or other start-up activity time shall not be counted as Operational Demonstration time.
- D. During the entire 14 day Operational Demonstration period, the operation of equipment will be assumed by the OWNER's personnel, under the direction of the CONTRACTOR. The CONTRACTOR shall provide labor and sufficient material to fully operate and maintain the work 24 hours per day, 7 days per week for the entire duration of the Operational Demonstrations.
- E. Prior to the Operational Demonstrations, all parts of the work designated for the operational demonstration shall have passed all required tests as specified. No testing shall be allowed during the Operational Demonstrations.
- F. During the Operational Demonstration period, CONTRACTOR shall obtain baseline operating data on equipment with motors greater than one horsepower. Baseline data shall include amperage, bearing temperatures, and vibration data obtained at intervals in the approved testing plan. Methods of measurement shall be in accordance with industry standards applicable for the motors being tested.
- G. All required maintenance and servicing prior to the date of Substantial Completion shall be performed by the CONTRACTOR at the specified interval and as necessary. All maintenance and servicing shall be noted in the Operational Demonstration Log.
- H. All outages of equipment or system(s) should be noted in the Operational Demonstration Log. Plant outages are considered a part of normal plant operation and will not invalidate the Operational Demonstration. The CONTRACTOR is responsible for the safe and orderly shutdown and restart of equipment as necessary in the event of an outage.

- I. CONTRACTOR and Performance Testing Manager shall attend Operational Demonstration coordination meetings as called by the ENGINEER to review operating conditions of equipment and systems.
- J. If during the Operational Demonstration, any part of the work fails to fully conform to the requirements of the Contract Documents, the Operational Demonstration shall be considered to have failed, and the work shall not be considered to be Substantially Complete, and the ENGINEER shall so notify the CONTRACTOR in writing. The Steere Farm project will require several start/stop procedures be simulated including power failures which test the ATS and generator. The specific number will be confirmed in review of the commissioning plan. If, during the Operation Demonstration, the provisions of the General Conditions are evoked to stop the work, the Operational Demonstration will also be considered to have failed.
- K. Re-testing Because of Disputed Testing Results or Procedures: In the case of an otherwise satisfactory Operational Demonstration, when there is doubt, dispute, or difference between ENGINEER and CONTRACTOR regarding testing results, methods, or equipment used in the Operational Demonstration testing, ENGINEER may order CONTRACTOR to repeat the testing. If repeat testing using such modified methods or equipment required by ENGINEER confirms the previous test, all costs of repeat test will be paid by OWNER. Otherwise all costs, including costs of the ENGINEER, labor, testing agencies, and inspections, shall be paid by CONTRACTOR.
- L. Post-test Inspection: After completing Operational Demonstration testing, check equipment for proper alignment and realign, as required. Check equipment for loose connections, unusual movement, and other indication of improper operating characteristics. Disassemble and inspect equipment and devices that exhibit unusual or unacceptable operating characteristics. Repair or replace defective Work to conform to the Contract Documents at no additional cost to OWNER.
- M. Upon failure of the Operational Demonstration, the CONTRACTOR shall promptly remedy any defects in the work and shall promptly reschedule and re-start the complete 14-day, (336 hours) Operational Demonstration time period. No Operational Demonstration time will be considered to have accrued to any part of the work by reason of a failed Operational Demonstration.
- N. During the Operational Demonstration, the OWNER may require or permit the Operational Demonstration to be suspended:
 - 1. As provided in the General Conditions.
 - 2. Upon the written request of the CONTRACTOR, to correct or adjust the work, when in the judgment of the ENGINEER such required correction or adjustment is insufficient to deem the Operational Demonstration to have failed.
 - 3. If the Operational Demonstration is suspended for any reason except failure, Operational Demonstration time shall accrue to the work from the time of the beginning of the Operational Demonstration to the time of the suspension.
 - 4. If the Operational Demonstration is suspended at the request of the CONTRACTOR, the CONTRACTOR shall continue operation and maintenance of the work without additional charges to the OWNER, according to the extent required by the Contract Documents and the OWNER. No Operational Demonstration time shall accrue to the Work during the period of suspension.

- O. Completion of the Operational Demonstration does not relieve the CONTRACTOR of its other requirements for Substantial Completion as required by the Contract Documents.

3.04 SCHEDULE

- A. CONTRACTOR shall complete operational demonstration prior to beginning work at next well house.

END OF SECTION

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SECTION 01820 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Training
- B. Instructor Manual
- C. Trainee Manual

1.02 SUBMITTALS

- A. Submit the following in accordance with Section 01330:
 - 1. Submit two copies of the outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 2. Submit resumes, including three outside references, for each instructor proposed for training program. The qualifications of the instructor shall include the type of training instructor has received for the specific equipment and previous training work experience.
 - 3. Submit two (2) electronic copies of each training module within seven (7) calendar days following the delivery of each training module.
 - 4. On each copy of the training module, provide an applied label with the following information:
 - a. Name of Project.
 - b. Training Session Name.
 - c. Name of Engineer.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - 5. At completion of training, submit complete training manual(s) for Owner's use prepared and bound in format matching operation and maintenance manuals and in a PDF electronic file. Include a table of contents with links to corresponding training components.
 - a. The PDF electronic file format shall be electronically searchable.

1.03 COORDINATION

- A. Contractor to coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of the Owner's personnel. Contractor shall schedule training sessions at least 60 days in advance.
- B. Contractor shall provide a minimum of two (2) general training sessions on the Motors. Each of the two training sessions shall cover all topics. Training sessions shall be on non-consecutive weeks to accommodate shift changes at the plant.
- C. Contractor shall provide a minimum of two (2) training sessions on the Natural Gas Generators. Training for the generators improvements shall be separate from the training on the motors. Each of the two training sessions shall cover all topics related to the generators.

Generator training sessions shall be on non-consecutive weeks to accommodate shift changes at the plant.

- D. Contractor shall provide a minimum of two (2) general training sessions on the Variable Frequency Drives. Each of the two training sessions shall cover all topics. Training sessions shall be on non-consecutive weeks to accommodate shift changes at the plant.
- E. Training sessions shall be provided prior to the operational demonstration.
- F. Contractor to coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- G. Contractor to coordinate content of training modules with content of accepted emergency, operation, and maintenance manuals. Do not submit instruction program(s) for review until the operation and maintenance data required under Section 01781 has been reviewed and accepted by Engineer.

PART 2 - PRODUCTS

2.01 INSTRUCTOR MANUAL

- A. The Contractor shall prepare an Instructor Manual or each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanical specialists and instrument technicians, and for water treatment plant operators, or other disciplines, depending upon the target audience.
- B. The Instructor Manual shall be consistent with the nomenclature and contents of the accepted Contractor's O&M Manuals required in Specification Section 01781. The O&M Manuals cannot be substituted for the Instructor Manual.
- C. The purpose of the Instructor Manual is to define the concepts and information that will be taught to each target audience and to describe the methods and materials to be used during the training. The Instructor Manual is designed to provide specific guidance to the Instructor regarding all aspects of the training program. The Instructor Manual shall include:
 - 1. Description of the equipment.
 - 2. Parts and equipment graphics.
 - 3. Safety procedures.
 - 4. Startup checks and procedures.
 - 5. Overview of routine operation, including startup and shutdown and operating parameters.
 - 6. Routine, preventive, and corrective maintenance procedures.
 - 7. Lubrication (schedule and type).
 - 8. Assembly and disassembly procedures.
 - 9. Troubleshooting procedures.
 - 10. Parts list.
 - 11. Special maintenance practices.
 - 12. Emergency shutdown.
- D. All manuals shall be presented in electronic format per the requirements of Specification Section 01330. All equipment shall be cross-referenced to the equipment tag identification numbers.

- E. Each Instructor Manual shall contain:
 - 1. Instructor Manual cover page.
 - 2. Instructor Manual table of contents.
 - 3. Lesson Plan cover page.
 - 4. Lesson Plan summary.
 - 5. Lesson Plan text, including:
 - a. Identity of the target audience (a separate Lesson Plan is required for each target audience, such as mechanical O&M personnel, electronic/electrical O&M personnel, etc.).
 - b. Length of the training program and each topic to be covered.
 - c. Performance and/or training objectives.
 - d. Outline of the material to be covered.
 - e. Training strategies to be used and interaction with the trainees.
 - f. Audio visual and/or support materials required, and when used or referred to during instruction.
 - g. A list of resource and/or reference materials.
 - 6. A copy of all training aids, including electronic files.
 - 7. A copy of trainee materials (handouts, reference materials, etc.) in electronic format.
- F. The Contractor shall submit the equipment manufacturer's lesson plans for acceptance by the Engineer no less than ninety (90) days prior to the date that the training is to take place.
- G. With the exception of cutaway models or other items expressly exempted by the Engineer, all training aids and trainee materials contained in the Instructor Manual or used in the delivery of training shall become the property of the Owner and may be duplicated by the Owner for its own use.
- H. The Contractor shall provide required acceptance and/or copyright releases obtained from those who own proprietary and/or copyrighted materials provided by the Contractor so that the materials can be reproduced by the Owner.

2.02 TRAINEE MANUAL

- A. Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required in the individual Specification Sections.
- B. The Contractor shall submit a Trainee Manual for each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanic specialists and instrument technicians, and for water treatment plant operators, or other disciplines, depending upon the target audience.
- C. The Trainee Manual shall be consistent with the nomenclature and content of the accepted Contractor O&M Manuals required in Specification Section 01781. The O&M Manual cannot be substituted for the Instructor Manual or Trainee Manual.
- D. The purpose of the Trainee Manual is to provide an organized package of information for use by trainees during the training sessions and as reference Water Treatment Plant (New) material for operation and maintenance in the future. The Trainee Manual shall include:
 - 1. Description of the equipment.
 - 2. Parts and equipment graphics including "exploded" views.

3. Safety procedures.
 4. Pre-startup checks.
 5. Startup procedures.
 6. Operation and monitoring procedures including normal operating parameters, and the operating limits of the equipment.
 7. Shutdown procedures.
 8. Troubleshooting procedures.
 9. Non-routine emergency procedures.
 10. Safety/Protective equipment required by Trainees.
- E. All manuals shall be presented in electronic format per the requirements of Specification Section 01330. All equipment shall be cross-referenced to the equipment tag identification numbers.
- F. The Contractor shall provide at least one hard copy of each Trainee Manual for each trainee. Hard copies shall be on 8.5" x 11" paper in a 3-hole D-ring binder.

PART 3 - EXECUTION

3.01 FACILITIES FOR TRAINING

- A. Use Owner's designated training facilities for specified field training programs (with the exception of remote training described in this section). Facilities shall include the project site, which shall be used for hands-on training programs. Coordinate use of Owner's facilities with Owner.

3.02 ON-SITE TRAINING

- A. Training shall include the following:
1. Equipment Overview (required for all types of operations and maintenance training):
 - a. Describe equipment's operating (process) function and performance objectives.
 - b. Describe equipment's fundamental operating principles and dynamics.
 - c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
 - d. Identify all support equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
 - e. Identify and describe safety precautions and potential hazards related to operation.
 - f. Identify and describe in detail safety and control interlocks.
 2. Operations Training:
 - a. Describe operating principles and practices.
 - b. Describe routine operating, start-up, and shutdown procedures.
 - c. Describe abnormal or emergency start-up, operating, and shutdown procedures that may apply.
 - d. Describe alarm conditions and responses to alarms.
 - e. Describe routine monitoring and recordkeeping procedures.

- f. Describe recommended housekeeping procedures.
 - g. Describe how to determine if corrective maintenance or an operating parameter adjustment is required.
- B. Maintenance Training:
- 1. Describe preventative maintenance inspection procedures required to: inspect equipment in operation, identify potential trouble symptoms and anticipate breakdowns, and forecast maintenance requirements (predictive maintenance).
 - 2. Define recommended preventative maintenance intervals for each component.
 - 3. Describe lubricant and replacement part recommendations and limitations.
 - 4. Describe appropriate cleaning practices and recommend intervals.
 - 5. Identify and describe use of special tools required for maintenance of equipment.
 - 6. Describe component removal, installation, and disassembly and assembly procedures.
 - 7. Perform “hands-on” demonstrations of preventive maintenance procedures.
 - 8. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
 - 9. Define recommended torquing, mounting, calibrating, and aligning procedures and settings, as appropriate.
 - 10. Describe recommended procedures to check and test equipment following corrective maintenance.
- C. Equipment Troubleshooting:
- 1. Define recommended systematic troubleshooting procedures.
 - 2. Provide component-specific troubleshooting checklists.
 - 3. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.
 - 4. Describe common corrective maintenance procedures with “hands on” demonstrations.
- D. Instrumentation/Controls Training:
- 1. Instrumentation and controls training shall be provided in accordance with Section 13410 Basic Instrumentation Requirements.
- E. Equipment to be covered during training shall be per the requirements of the individual sections of the Contract Documents. This may include, but is not limited to the following topics listed in Table 01820-A, Training Summary Table.

01820-A, Training Summary Table

Equipment	Specification Section
Level Measurements	13423
Pressure Measurements	13424
Temperature Measurements	13426
Indicators	13441
Sump Pumps	15446
Low-Intensity Gas Fired Radiant Heaters	15546
Computer Room Air Conditioners	15734
Power Ventilators	15838
Intake and Relief Ventilators	15856
Motors	16220
Standby Natural Gas Generators	16231
Transfer Switches	16238
Motor Controllers	16420
Variable Frequency Drive	16480
Lighting Fixtures	16510

3.03 MANUFACTURER'S REMOTE TRAINING CLASS (ALTERNATE)

- A. Provide transportation (departing and returning), accommodations (lodging and meals), and a VFD training class at the manufacturer's facilities for two City employees. The training class shall be a course in operations, maintenance and troubleshooting of VFDs similar to those provided in this project. The trainer will be experienced in the topics and with conducting training courses. Owner's travel will originate from Detroit, Michigan and all flights (if applicable) shall be direct, if available.
- B. Provide transportation (departing and returning), accommodations (lodging and meals), and a Generator training class at the manufacturer's facilities for two City employees. The training class shall be a course in operations, maintenance and troubleshooting of Generators similar to those provided in this project. The trainer will be experienced in the topics and with conducting training courses. Owner's travel will originate from Detroit, Michigan and all flights (if applicable) shall be direct, if available.

3.04 SCHEDULE

- A. The Contractor shall coordinate the manufacturer's training services with the Owner and the Engineer, providing a minimum of thirty (30) days prior notice of training, subject to the acceptance of the Engineer and the Owner.
- B. Training shall occur prior to the operational demonstration.

END OF SECTION

SECTION 01830 - FACILITY ONLINE TRAINING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. In addition to the training requirements described in other specification section, the Contractor shall engage an online learning modules provider to develop customized online learning modules for this project. The modules shall be developed; quizzes and tests shall be prepared by the online learning modules provider with the full cooperation of the equipment manufacturers. Course work, hosting services and programming shall be provided by 360water, Inc. (local representative is HESCO (586) 558-8380) or approved equal.
- B. All costs associated with the services described herein as well as coordination requirements from the Contractor are considered included in the bid alternate.

1.02 EQUIPMENT AND SYSTEMS TRAINING MODULES

- A. Training modules shall be furnished for the following equipment and systems:

Items

- Remote and Local Pump Operation
- VFD
- Back- Up Generator
- SCADA Operation Tutorial Course

1.03 QUALIFICATIONS

- A. The online learning modules provider shall have provided the platform to a minimum of five municipal wastewater clients and shall have been in business for a minimum of three years. The Contractor shall provide a list, with contact phone numbers, of three municipal wastewater treatment facility installations for which the online learning modules provider has completed technical training similar in scope to this project.

1.04 SUBMITTALS AND NOTICES

- A. Equipment manufacturer supplied submittal material shall include, at minimum, the following operation and maintenance manual components to the online learning modules provider for use in preparing training course modules for the equipment:
1. Brochures;
 2. Start-up and shut down procedures;
 3. Operation and maintenance material required to operate and maintain the equipment, Troubleshooting guide; and
 4. Safety.
- B. Any additional material the equipment manufacturer has, which will assist the City to properly operate and maintain the equipment, shall be furnished to the online learning modules provider. The manufacturer shall provide this in electronic format (searchable PDF) and hardcopy.

PART 2 – MATERIALS AND EQUIPMENT

2.01 FACILITY ONLINE TRAINING

- A. The Modules shall be able to evaluate and test the operators on:
 - 1. Start-up /Shut down of equipment,
 - 2. Basic operations, maintenance and safety, and
 - 3. Trouble shooting techniques.
- B. The Online Education Program shall include the following functions for each module.
 - 1. Intermittent quizzes and test questions;
 - 2. Wrong answer notification;
 - 3. Generation of a certificate of completion (100% proficiency shall be required before a certificate of completion is generated);
 - 4. A real time clock on screen that verifies the time spent on the course material;
 - 5. The software program shall automatically bookmark when the operator leaves a course (in case of power outage or an emergency in the facility);
 - 6. The web-based platform shall be browser independent;
- C. The online learning modules provider shall fill out the required paperwork for the City to submit the courses to the appropriate Regulatory Agency. This is in the event of the facility choosing to apply for CH/CEU credits for their training program.
- D. The Contractor shall coordinate with his equipment manufacturers to provide all relevant information necessary for the online learning provider to train a new operator on mandatory procedures.
- E. The hosting of this service (which is included in the contractor's bid) is for a minimum of three years from the date of Condition Acceptance. A hard copy and an electronic version of all training modules shall be provided to the City to use for other non-online training programs. At the end of the 3-year period, the City can negotiate with the provider to continue with the program; or the City can provide an acceptable server for the program to be delivered to the City to run on their intranet. Ownership of all material will become the City's.

2.02 REVIEW OF ONLINE TRAINING

- A. The Contractor's equipment manufacturers shall review the courseware created for the equipment they are supplying. Comments and corrections shall be required within a schedule determined by the Contractor.
- B. Following completion of revisions to the courseware to reflect the equipment manufacturers' comments, the Contractor shall submit the draft courseware to the Engineer for review and comments. Upon receipt of the Engineer's comments further revisions shall be made to the courseware to reflect the Engineer's review comments.

2.03 DATA CAPTURE

- A. The online learning modules provider shall work with the staff at the installation, onsite for a minimum of 3 working days. During these visits the data capture personnel will capture digital images and video of the equipment supplied for the project and courseware written. The online provider will modify the relevant images and video, and then insert them into the

courses. During one of the trips the online learning modules provider shall review some of the courseware with an operations supervisor and a maintenance supervisor to demonstrate the review process that will be conducted in house by the City.

2.04 SCADA TRAINING

- A. SCADA training modules shall be furnished to review the functions of the pump stations and the monitoring. The City will complete a walk thru of the SCADA screens and their functionality. Online training provider will video tape the session to create tutorials for the operators.

2.05 PROCESS COURSEWARE

- A. The Engineer and the Online Training Provider will work to create Project Process Manual Courses. The Online Training Provider will notify the contractor when the courseware has been added to the client's website library. Final review of all process courses will go through the Engineer.
- B. The City will supply the O&M manuals in an electronic, open, and un-locked format. The manual size will be a maximum of eighty (80) pages. From the manual, a maximum of Two (2) O&M courses will be developed by the online provider.
- C. Regarding test questions, the City will highlight any information in the O&M Manual mandatory for the student's operational development. The Online Training Provider shall base the questions on that material. The City will review the questions prior to programming. The City will need to review the test questions and approve the content prior to programming.

2.06 ELECTRONIC O&M INTERFACE

- A. The Online Training Provider shall provide a training website that also hosts the O&M documents themselves, for plant reference. This document storage solution shall include graphical interface screens to be programmed with the training modules. These screens will show hyperlinks to the O&M materials and take the form of an interactive plant map of the 3 lift stations. The map feature will allow the operators to see the new equipment on maps for this project. The map will show the location of each piece of equipment. Hyperlinks connecting the user to the electronic O&M materials will be created. The site will link training to the appropriate O&M PDFs. Dropdown menus should be used to organize all content on the site for ease of navigation.
- B. The website, the online courses, and the O&M documents, will all be viewable using any web browser. In addition, O&M documents will always be offered with the option of downloading as well.

PART 3 – EXECUTION

- A. SCHEDULE - These courses should be completed prior to substantial completion.

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SECTION 02225 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Selective Demolition Work requires selective removal and off-Site disposal of following:
 - 1. Portions of building structure shown on Drawings or required to accommodate new construction.
 - 2. Removal, protection, and reinstallation of existing fixtures and equipment items shown or marked as "remove and reinstall."
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplemental General Conditions and Division 1 Sections, apply to Work of this Section.

1.02 DEFINITIONS

- A. Remove: Remove and dispose of items shown or scheduled. Discard demolished or removed items except for those shown to remain, those shown as reinstalled, those shown as salvaged, and historical items that are to remain OWNER's property.
- B. Remove and Reinstall: Remove items shown; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in same location or in location shown.
- C. Existing to Remain: Protect construction or items shown to remain against damage during selective demolition operations. When permitted by ENGINEER, CONTRACTOR may elect to remove items to suitable, protected storage location during selective demolition and properly clean and reinstall items in their original locations.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Proposed dust control measures.
 - 2. Proposed noise control measures.
 - 3. Proposed haul routes between Site and disposal areas before commencing this Work.
- B. Submit Schedules listed below to OWNER.
 - 1. Detailed sequence of selective demolition and removal Work, with starting and ending dates for each activity.
 - 2. Inventory list of removed existing equipment not reused in Contract Work. Submit lists to OWNER. OWNER to determine or select items for retention by OWNER.
 - 3. Inventory list of removed and salvaged items.
 - 4. Inventory list of OWNER-removed items.
 - 5. Interruption of utility service.
 - 6. Coordination for shutoff, capping, and continuation of utility services.
 - 7. Detailed sequence of selective demolition and removal Work to ensure uninterrupted progress of OWNER's on-Site operations.

8. Coordination of OWNER's continuing occupancy of portions of existing building and of OWNER's partial occupancy of completed Work.
 9. Locations of temporary partitions and means of egress.
 10. Items to remain and protection measures from environment and construction activities.
- C. Inventory list of existing equipment to be removed and not reused in Work. OWNER to determine or select items for retention by OWNER.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Demolition operations shall comply with OSHA and EPA requirements and EPA notification regulations insofar as they apply to selective demolition Work under this Contract.
 2. Comply with hauling and disposal regulations of authorities having jurisdiction.
 3. If hazardous materials are found during selective demolition operations, comply with applicable paragraphs of General Conditions and Supplemental General Conditions.
- B. Pre-Installation Meetings:
1. Do not close, block, or obstruct streets, walks, or other occupied or used facilities without written permission from authorities having jurisdiction.
 - a. Use alternative routes around closed or obstructed routes if required by governing regulations.
 2. Coordinate with OWNER's continuing occupation of portions of existing building, with OWNER's partial occupancy of completed new addition, and with OWNER's reduced usage during summer months.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Disassemble or cut large equipment items into smaller pieces to promote safe removal and transportation.
1. Transport and unload items requested by OWNER at designated Site within distance of 5 miles.
 2. Haul away and dispose of debris and materials neither retained by OWNER, nor reused or reinstalled.
 3. Arrange for disposal areas.
 4. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
- B. Unloading Salvage Items: Where shown on Drawings as "Remove and Salvage," carefully remove shown items, clean, store, and turn over to OWNER and obtain receipt. OWNER will designate site for receiving items.
- C. Handling: CONTRACTOR shall take every precaution to prevent spillage of materials being hauled in public streets.
1. It shall be CONTRACTOR's responsibility to immediately clean spillage that may accidentally occur.
 2. Do not burn removed material on or within Project Site.

1.06 PROJECT CONDITIONS

- A. Materials Ownership:
 - 1. Salvage Materials: Demolished materials shall become CONTRACTOR's property, except for items or materials shown as reused, salvaged, reinstalled, or otherwise shown to remain OWNER's property. Remove demolished material promptly from Site with further disposition at CONTRACTOR's option.
 - 2. Historical artifacts, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other articles of historical significance remain property of OWNER. Notify OWNER's Representative when these items are found and obtain method of removal and salvage from OWNER.
 - 3. Transport items of salvageable value to CONTRACTOR (CONTRACTOR's area) as they are removed. Storage or sale of demolition items on-Site is not allowed.
- B. Environmental Requirements: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations relating to environmental protection. Do not use water when it may create hazardous or objectionable conditions including ice, flooding, and pollution.
- C. OWNER assumes no responsibility for actual condition of items or structures scheduled for selective demolition.
- D. OWNER will maintain conditions existing at Contract commencement insofar as practical.
- E. Known Hazardous Materials are listed in the appendix of this document.

1.07 SEQUENCING

- A. Conduct selective demolition Work in manner that minimizes need for disruption or interference of OWNER's normal on-site operations.
- B. Coordinate with OWNER's use of existing buildings.
- C. Include coordination for shutoff, capping, and continuation of utility services together with details for dust and noise control protection to ensure uninterrupted on-Site operations by OWNER.

1.08 SCHEDULING

- A. Schedule: Submit schedule showing proposed methods and sequence of operations for selective demolition Work to OWNER's Representative for review before commencement of Work.
- B. Arrange selective demolition schedule so as not to interfere with OWNER's on-Site operations.
- C. Give OWNER advance notice of demolition activities which affect OWNER's normal operations. Notice requirements are given elsewhere in this document.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Site Verification of Conditions: Before beginning selective demolition Work, inspect areas of Work. Survey existing conditions and correlate with requirements shown to determine extent of selective demolition required. Photograph existing structure surfaces, equipment, or surrounding properties which could be misconstrued as damage resulting from selective demolition Work. File with OWNER's Representative before starting Work.
- B. Inventory and record condition of items scheduled as "remove and re-install" or items scheduled as "remove and salvage."
- C. Verify disconnection and capping of utilities within the affected area of Work.
- D. If unanticipated mechanical, electrical, or structural elements conflict with intended function or design, investigate and measure nature and extent of conflicts. Promptly submit detailed written reports to OWNER's Representative. Pending receipt of the directive from OWNER's Representative, rearrange selective demolition schedule to continue general job progress without delay.

3.02 UTILITY SERVICES

- A. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction.
- B. Maintain existing utilities shown as remaining. Keep in service and protect existing utilities against damage during selective demolition operations and environmental conditions.
- C. Locate, identify, stub off, and disconnect utility services that are not to remain active.
 - 1. OWNER will arrange to shut off designated utilities when requested by CONTRACTOR.
 - 2. Arrange to shut off utilities with utility companies.
- D. Cut off pipe or conduit in walls or partitions scheduled for removal. Cap, valve or plug, and seal remaining portion of pipe or conduit after bypassing.

3.03 PREPARATION

- A. Drain, purge, or remove, collect and dispose of chemicals, gases, explosives, acids, flammable, or other dangerous material before proceeding with selective demolition operations.
- B. Cover and protect furniture, equipment, and permanent fixtures from soiling or damage while demolition Work is done in rooms or areas where items remain in place.

- C. Protect existing finish Work that remains in place and becomes exposed during selective demolition operations.
- D. Protect floors with suitable coverings when necessary.
- E. Where selective demolition occurs immediately adjacent to occupied portions of building, or to separate areas of noisy or extensive dirt or dust operations, construct and maintain temporary, insulated, fire-rated solid dustproof partitions.
 - 1. Construct dustproof partitions of minimum 4-inch studs, 5/8-inch-thick drywall (joints taped on occupied side), 1/2-inch fire-retardant plywood on demolition side, and fill partition cavity with sound-deadening insulation.
 - 2. Equip partitions with dustproof doors and security locks if required.
- F. Provide weatherproof closures for exterior openings resulting from selective demolition Work. Provide temporary weather protection during interval between selective demolition and removal of existing construction on exterior surfaces, and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
- G. Provide and ensure free and safe passage of OWNER's personnel and general public to and from occupied portions of building around selective demolition areas.
 - 1. Provide temporary barricades and other forms of protection to protect OWNER's personnel and general public from injury.
 - 2. Build temporary covered passageways required by authorities having jurisdiction.
- H. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of demolished structures or elements, or adjacent facilities or Work to remain.
- I. Cease operations and notify OWNER's Representative immediately if safety of structure seems endangered. Take precautions to support structure until determination is made for continuing operations.
- J. Remove protection at completion of Work.

3.04 DEMOLITION

- A. Special Techniques: Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- B. Demolish foundation walls to depth of not less than 12 inches below proposed ground surface. Demolish and remove below-grade wood or metal construction. Break up below-grade concrete slabs.
- C. For interior slabs on grade, use power saw or removal methods that do not crack or structurally disturb adjacent slabs or partitions.
- D. Completely fill below-grade areas and voids resulting from selective demolition Work. Either:
 - 1. Provide fill consisting of approved earth, gravel, or sand.

2. Fill shall be free of trash, debris, stones over 6-inch diameter, roots, or other organic matter.
- OR
3. Fill below-grade areas and voids with Class F concrete.
- E. Explosives: Use of explosives is not allowed.
- F. Interface with Other Work: Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors, or framing.
- G. Site Tolerances: Provide services for effective air and water pollution controls required by local authorities having jurisdiction.

3.05 REPAIR\RESTORATION

- A. Repair damages caused by demolition that was more extensive than required.
- B. Return structures and surfaces to condition existing before commencement of selective demolition Work.
- C. Repair adjacent construction or surfaces soiled or damaged by selective demolition Work.
- D. Promptly repair damages caused to adjacent facilities by selective demolition Work at no cost to OWNER.

3.06 CLEANING

- A. CONTRACTOR shall maintain an order of neatness and good housekeeping comparable to that observed by OWNER.
- B. Keep tools, scaffolding, and other demolition equipment in neat and orderly arrangement.
- C. Remove dirt and debris resulting from CONTRACTOR's demolition operations from Site daily. Dirt and debris shall not collect or interfere with OWNER's facility operations.
- D. Upon completion of selective demolition Work, remove tools, equipment, and demolished materials from Site. Remove protection and leave interior areas broom clean.

END OF SECTION

SECTION 02230 - SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Protection of existing trees.
 - 2. Removal of trees and other vegetation.
 - 3. Topsoil stripping.
 - 4. Clearing and grubbing.
 - 5. Removing above-grade improvements.
 - 6. Removing below-grade improvements.

1.02 DEFINITIONS

- A. Topsoil: Friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.

1.03 PROJECT CONDITIONS

- A. Traffic: Conduct Site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.
 - 1. Protect improvements on adjoining properties and on OWNER's property.
 - 2. Restore damaged improvements to their original condition, as acceptable to property OWNER.
- B. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, or not marked for removal, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.
 - 1. Water trees and other vegetation to remain within limits of Work as required to maintain their health during course of construction operations.

2. Provide protection for roots over 1-1/2-inch diameter that are cut during construction operations. Coat cut faces with emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
 3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to ENGINEER. Employ a licensed arborist to repair damages to trees and shrubs.
 4. Replace trees which cannot be repaired and restored to full-growth status, as determined by arborist.
- C. Carefully remove items indicated to be salvaged, and store on OWNER's premises where indicated or directed.

3.02 SITE CLEARING

- A. Remove trees, shrubs, grass, and other vegetation, improvements, or obstructions as required to permit installation of new construction. Remove similar items elsewhere on Site or premises as specifically indicated. "Removal" includes digging out and off-site disposing of stumps and roots.
1. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.
 2. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
 - a. Remove heavy growths of grass from areas before stripping.
 - b. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.
 - c. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion.
 - d. Dispose of unsuitable or excess topsoil same as specified for disposal of waste material.
- B. Clearing and Grubbing: Clear Site of trees, shrubs, and other vegetation, except for those indicated to be left standing.
1. Completely remove stumps, roots, and other debris protruding through ground surface.
 2. Use only hand methods for grubbing inside drip line of trees indicated to remain.
 3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
 4. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to a density equal to adjacent original ground.
- C. Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
1. Abandonment or removal of certain underground pipe or conduits may be indicated on mechanical or electrical Drawings, and is included under Work of related Divisions 15 and 16 Sections. Removal of abandoned underground piping or conduit interfering with construction is included under this Section.

3.03 DISPOSAL OF WASTE MATERIALS

- A. Burning is not permitted on OWNER's property.
- B. Remove waste materials and unsuitable or excess topsoil from OWNER's property at CONTRACTOR's expense. CONTRACTOR shall make own arrangements for obtaining disposal areas. Proposed haul routes between the Site and disposal areas shall be submitted by CONTRACTOR to ENGINEER for approval prior to commencing this Work.

END OF SECTION

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SECTION 02240 - DEWATERING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:

1. Dewatering consisting of performing work necessary to lower and control groundwater levels and hydrostatic pressures to permit excavation and construction to be performed in near-dry conditions. Control of surface and subsurface water, ice, and snow are part of dewatering requirements.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 DEWATERING

- A. Provide an adequate system to lower and control groundwater in order to permit excavation, construction of structures, and placement of fill materials under dry conditions. Install sufficient dewatering equipment to pre-drain water-bearing strata above and below bottom of structure foundations, drains, sewers, and other excavations. The excavations shall be kept dry until exterior walls have been completed and until the structures have been backfilled. Drainage ditches shall not be placed within the area to be occupied by any structure except where permitted by ENGINEER. When such ditches are placed beneath the structures, they shall be backfilled with Class C concrete.
- B. Reduce hydrostatic head in water-bearing strata below structure foundations, drains, sewers, and other excavations to extent that water level and piezometric water levels in construction areas are below prevailing excavation surface.
- C. Prior to excavation below groundwater level, place system into operation to lower water levels as required and then operate it continuously 24 hours a day, 7 days a week until drains, sewers, and structures have been constructed, including placement of fill materials, and until dewatering is no longer required.
- D. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of Work under construction or completed. Dispose of water in a manner to avoid inconvenience to others engaged in work about Site. Provide sumps, sedimentation tanks, and other flow control devices as required by governing authorities. Effluent water from dewatering methods shall be sediment free or be discharged through an ENGINEER-approved sediment entrapment basin.

- E. Provide standby equipment on Site, installed and available for immediate operation if required to maintain dewatering on a continuous basis in event any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform work as may be required to restore damaged structures and foundation soils at no additional expense.

END OF SECTION

SECTION 02310 - EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Preparing of subgrade for building slabs, walks, and pavements.
 - 2. Aggregate base courses for walks and pavements, aggregate surface courses, and aggregate shoulders.
 - 3. Drainage fill course for support of building slabs is included as part of this Work.
 - 4. Excavating and backfilling of trenches within building lines.
 - 5. Excavating and backfilling for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.
- B. Final Grading, placement, and preparation of topsoil for lawns, planting, and paving are specified in other Division 2 Sections.

1.02 DEFINITIONS

- A. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.
- B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of ENGINEER. Unauthorized excavation, as well as remedial Work directed by ENGINEER, shall be at CONTRACTOR's expense.
 - 1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to ENGINEER.
 - 2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification unless otherwise directed by ENGINEER.
- C. Additional Excavation: When excavation has reached required subgrade elevations, notify ENGINEER, who will make an inspection of conditions. If ENGINEER determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by ENGINEER. The Contract Price may be adjusted by an appropriate Contract Modification.
 - 1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in Work.
- D. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, drainage fill, or topsoil materials.
- E. Subbase: The layer of specified materials of designed thickness placed to the subgrade as part of the pavement structure.
- F. Base Course: The layer or layers of specified or selected material of designed thickness placed on a subbase or a subgrade to support a surface course.

- G. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

1.03 SUBMITTALS

- A. Test Reports: Submit the following reports directly to ENGINEER from the testing services, with copy to CONTRACTOR:
 1. Test reports on borrow material.
 2. Verification of suitability of each footing subgrade material in accordance with specified requirements.
 3. Gradation analysis for subbase and base materials.
 4. Field reports; in-place soil density tests will be performed by a representative of OWNER.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation Work in compliance with applicable requirements of authorities having jurisdiction. Construct subbase, base, and surface courses in accordance with Michigan Department of Transportation (MDOT) Standard Specifications for Construction.
- B. Testing and Inspection Service: See section 01450.

1.05 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities in areas of excavation Work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility and Owner immediately for directions. Cooperate with OWNER and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
 2. Do not interrupt existing utilities serving facilities occupied by OWNER or others, during occupied hours, except when permitted in writing by ENGINEER, and then only after acceptable temporary utility services have been provided.
 3. Provide notice to ENGINEER as described elsewhere in these specifications, and receive written notice to proceed before interrupting any utility.
 4. Demolish and completely remove from Site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
- B. Use of Explosives: Use of explosives is not permitted.
- C. Protection of Persons and Property: Barricade open excavations occurring as part of this Work and post with warning lights.
 1. Operate warning lights as recommended by authorities having jurisdiction.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 3. Perform excavation by hand within drip line of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Satisfactory soil materials are defined as those complying with ASTM D 2487, Soil Classification Groups GW, GP, GM, SM, SW, and SP.
- B. Unsatisfactory soil materials are defined as those complying with ASTM D 2487, Soil Classification Groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.
- C. Sand Bedding and Backfill: MDOT Specifications - Granular Materials Class III.
- D. Subbase Material: MDOT Specifications - Granular Materials Class II.
- E. Aggregate Base: Aggregate shall meet MDOT Specification 21AA or 22A.
- F. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve and not more than 5 percent passing a No. 4 sieve.
- G. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.
- H. Aggregate Surfaces and Shoulders: Surfaces on which no bituminous or concrete pavement is to be placed shall meet MDOT Specification 23A or 22A.
- I. Driveways and Access Drives: The project access drive shall be scarified, graded, top dressed and compacted at the end of the project.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.
- B. Excavation Classifications: The following classifications of excavation will be made when rock is encountered:
 - 1. Earth excavation includes excavation of pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.
 - 2. Rock excavation for trenches and pits includes removal and disposal of materials and obstructions encountered that cannot be excavated with a track-mounted power excavator, equivalent to Caterpillar Model No. 215C LC, and rated at not less than 115 horsepower flywheel power and 32,000-pound drawbar pull and equipped with a short stick and a 42-inch wide, short tip radius rock bucket rated at 0.81 cubic yard (heaped) capacity. Trenches in excess

of 10 feet in width and pits in excess of 30 feet in either length or width are classified as open excavation.

3. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered that cannot be dislodged and excavated with modern, track-mounted, heavy-duty excavating equipment without drilling, blasting, or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973, or equivalent track-mounted loader, rated at not less than 210 horsepower flywheel power and developing minimum of 45,000-pound breakout force (measured in accordance with SAE J732).
 - a. Typical of materials classified as rock are boulders 1/2 cubic yard or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.
 - b. Intermittent drilling, blasting, or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
- C. Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by ENGINEER. Such excavation will be paid on basis of Contract Conditions relative to changes in Work.
- D. Rock payment lines are limited to the following:
 1. Two feet outside of concrete work for which forms are required, except footings.
 2. One foot outside perimeter of footings.
 3. In pipe trenches, 6 inches below invert elevation of pipe and 2 feet wider than inside diameter of pipe, but not less than 3 feet minimum trench width.
 4. Outside dimensions of concrete work where no forms are required.
 5. Under slabs on grade, 6 inches below bottom of concrete slab.

3.02 STABILITY OF EXCAVATIONS

- A. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.
 1. Provide permanent steel sheet piling or pressure-creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops a minimum of 2'-6" below final grade and leave permanently in place.

3.03 DEWATERING

- A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding Project Site and surrounding area or from impacting the subgrade.
 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and

- discharge lines, and other dewatering system components necessary to convey water away from excavations.
2. Remove subsurface water below structure excavations until the water level is far enough below the subgrade elevation to allow the required subgrade compaction. Dewatering shall be completed before the subgrade is exposed and before ENGINEER inspects the subgrade condition. Place dewatering wells outside the load-bearing influence area of the structure foundation. Provide test pits, well points, piping, pumps, electrical power, and other equipment necessary for dewatering.
 3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.04 STORAGE OF EXCAVATED MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
 1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
 2. Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill.

3.05 EXCAVATION FOR STRUCTURES

- A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.
 2. For pile foundations, stop excavations from 6 to 12 inches above bottom of footing before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavations, intended for bearing surface.

3.06 EXCAVATION FOR PAVEMENTS

- A. Cut surface under pavements to comply with cross-sections, elevations, and grades as indicated.

3.07 TRENCH EXCAVATION FOR PIPES AND CONDUIT

- A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.
- B. Excavate trenches for conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line or to elevations as shown on Drawings.

1. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with a 6-inch layer of sand or pea gravel prior to installation of pipe.
2. For pipes or conduit less than 6 inches in nominal size, and for flat-bottomed, multiple-duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
3. For pipes and equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Where the subgrade is disturbed, fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads ensure continuous bearing of pipe barrel on bearing surface.

3.08 BACKFILL AND FILL

- A. Place and compact sand to a level 1 foot above the top of the pipe or conduit, then place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.
 1. Under grassed areas, use satisfactory excavated or borrow material.
 2. Under walks and pavements, use subbase material.
 3. Under steps, use subbase material.
 4. Under building slabs, use drainage fill material. Protect vapor barrier from puncture by placing sand between gravel and vapor barrier.
 5. Under piping and conduit and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.
 6. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
 - a. Concrete is specified in Division 3.
 - b. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by ENGINEER. Use care in backfilling to avoid damage or displacement of pipe systems.
- B. Backfill excavations as promptly as Work permits, but not until completion of the following:
 1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
 3. Removal of concrete formwork.
 4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
 5. Removal of trash and debris from excavation.
 6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.09 PLACEMENT AND COMPACTION

- A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

1. When existing ground surface has a density less than that specified in this Article for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.
- B. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
 - C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.
 - E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by ENGINEER if soil density tests indicate inadequate compaction.
 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
 - a. Under structures, building slabs and steps, and pavements, compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
 - b. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum density.
 - c. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
 - a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 - b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.10 GRADING

- F. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
- G. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:
 1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.

2. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
 3. Pavements: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.
- H. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch when tested with a 10-foot straightedge.
- I. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.11 PAVEMENT SUBBASE COURSE

- A. Subbase course consists of placing subbase material, in layers of specified thickness, over subgrade surface to support a pavement base course.
1. Refer to other Division 2 Sections for restoration specifications.
- B. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12-inch width of shoulder simultaneous with the compaction and rolling of each layer of subbase course.
- C. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
1. When a compacted subbase course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 15 inches thick, place material in equal layers, except no single layer more than 8 inches or less than 3 inches in thickness when compacted. Subgrade shall be compacted to 95 percent maximum density.

3.12 AGGREGATE BASE COURSE

- A. Aggregate base course consists of placing base materials of the type and thickness, over a prepared subgrade or subbase, as shown on Drawings.
- B. Placing: Aggregate base shall be placed in accordance with MDOT Specifications. Aggregate base shall be conditioned in accordance with Method No. 2.

3.13 AGGREGATE SURFACE COURSE

- A. Aggregate surface courses consist of constructing an aggregate surface on prepared subgrade or subbase, an aggregate base or an existing aggregate surface.
- B. Placing: Aggregate surface courses shall be constructed in accordance with MDOT Specifications.

3.14 AGGREGATE SHOULDERS

- A. Aggregate shoulders and approaches shall be constructed to the thickness and dimensions as shown on Drawings.

- B. Placing: Aggregate shoulders and approaches shall be constructed in accordance with MDOT Specifications for Class A shoulders.

3.15 BUILDING SLAB DRAINAGE COURSE

- A. Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.
- B. Placing: Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.
 - 1. When a compacted drainage course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.16 FIELD QUALITY CONTROL

- A. Quality Control Testing during Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

3.17 EROSION CONTROL

- A. Provide erosion control methods in accordance with details shown on Drawings and/or requirements of authorities having jurisdiction.

3.18 MAINTENANCE

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- D. Settling: Where settling is measurable or observable at excavated areas during general Project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal to Designated Areas on OWNER's Property: Transport acceptable excess excavated material to designated soil storage areas on OWNER's property. Stockpile soil or spread as directed by ENGINEER.
 - 1. Transport waste material, including unacceptable excavated material, trash, and debris to designated spoil areas on OWNER's property and dispose of as directed.

- B. Removal from OWNER's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off OWNER's property.
 - 1. Remove excess excavated material, trash, debris, and waste materials and dispose of it off OWNER's property.

END OF SECTION

SECTION 02510 - WATER DISTRIBUTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Buried water services as shown on Drawings.
- B. Plugs in open ends of pipe, temporary bulkheads, protection of surface and subsurface improvements, cleaning, testing, and disinfection, as required, shall be included in the lump sum bid price
- C. Work shall include the dismantling of existing piping and supports, where required and/or shown or noted on Drawings. Piping connections shall be made to existing piping, valves, gates, measuring devices, pumps, and other equipment, including equipment erected under other Divisions.
- D. Products Installed But Not Supplied Under This Section: Unless otherwise noted on Drawings, or stated in this Section, all piping shall be furnished under Section 15050, and installed under this Section.
 - 1. All necessary joint and coupling materials, including bolts, nuts, and gaskets, wall castings or sleeves, supports, anchors, blocking, harnesses, and other necessary closure pipe sections and standard or special fittings shall be furnished under Section 15050 and installed under this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.
- B. Record Drawings: At Project closeout, submit Record Drawings of installed products, in accordance with requirements of Section 01770.
 - 1. CONTRACTOR shall submit 1 complete set of Drawings showing the location of pipe valves and fittings as installed. The location of all valve boxes shall be witnessed to at least 2 permanent reference points, such as utility poles, building, etc. Other valve boxes shall not be used as reference points.
- C. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. All Work under this Section shall be done in accordance with standard practices as recommended by manufacturer and AWWA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Corporation Stops:
 - a. Mueller Co.
 - b. The Ford Meter Box Co.
 - 2. Curb Stops:
 - a. Mueller Co.
 - b. The Ford Meter Box Co.
 - 3. Curb Boxes:
 - a. Mueller Co.
 - b. The Ford Meter Box Co.

2.02 MATERIALS

- A. Service Connections:
 - 1. Type K, soft temper copper, ASTM B 88, water tube with flared joints for underground service.
- B. Corporation Stops shall conform to AWWA C800 with copper American National Taper pipe threads conforming to ASA B2.1 1960. Inlet and outlet shall be of same size as service connection.
- C. Curb Stops: Curb stops shall conform to AWWA C800, shall be drip-tight, ball type, and shall be of same size as service connection.
- D. Curb Boxes: Curb boxes shall fit curb stop and be extension type, of suitable length complete with lid and stationary rod.

2.03 WALL AND SLAB SLEEVES AND CASTING

- A. At all points where pipes must pass through the walls, floors, or slabs of structures, CONTRACTOR shall furnish and install suitable sleeves or wall castings. Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be sealed at the inside and outside wall faces on walls exposed to earth or water/sewage, at one face of other walls, and at the top surface of floors and slabs with a rubber link seal.
- B. Steel sleeves and wall pipe shall not be painted in areas to be embedded in the concrete. Under this Section, all loose rust, scale, grease, or oil shall be removed prior to pouring of the concrete.
- C. Where watertightness is essential and at other locations where indicated on Drawings, wall castings, and sleeves shall be provided with an intermediate flange located approximately at the center of the wall.
- D. Sleeves and castings at the point of manufacture shall be coated on the inside with a universal rust-inhibitive primer 1.5 to 2.0 mils minimum dry thickness.
- E. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers. The sealing element shall be made of synthetic rubber material especially compounded to

resist aging, ozone, sunlight, and chemical action. Bolts and metal parts shall be made of galvanized or cadmium-plated steel to resist corrosion. Rubber link seal joints shall be submitted to ENGINEER for approval.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. CONTRACTOR's attention is directed to Section 15050 for installation, field quality control, field repair, disinfection, and field testing of items of Work to be installed under this Section.
- B. Service connections shall be as noted on Drawings.
- C. Corporation stops shall be the same size as the service connection and shall be installed per AWWA standards.
- D. Connections to Existing Facilities:
 - 1. CONTRACTOR shall furnish all labor and materials required for the connection of piping under this Contract to existing structures as called for on Drawings.
 - 2. Where breaking holes for connections to existing structures, care shall be taken to prevent debris from entering.
 - 3. After installation of the pipe, the structure shall be pointed up around the pipe, both on the inside and outside so that it is restored to a watertight condition.

3.02 REPAIR

- A. Repair of all damaged interior pipe coatings, ground-buried exterior pipe coatings and galvanized coatings shall be under this Section. Repair of exposed painted pipe shall be as specified under Section 09900.
- B. Damaged linings, coatings, and wrapping shall be repaired under this Section and, if possible, before pipe is laid.
 - 1. Surfaces shall be thoroughly cleaned, dried, and free of old materials.
 - 2. They shall then be given a field coating of the same material as specified for the pipe.
 - 3. Coating shall meet the requirements of AWWA C203, AWWA C210, or AWWA C602 as approved by ENGINEER.

END OF SECTION

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SECTION 02805 - RESTORATION WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Work including the replacement of all permanent type roadway bases and surfaces, concrete sidewalks, curbs and gutters, trees, lawns, and driveways damaged or removed due to the construction of pipe, trenches and appurtenant structures. All such Work shall be in accordance with the Best Modern Practice, OWNER's standards, and/or as specified herein.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.
- C. Work shall comply with City of Ann Arbor Public Services Department, Standard Specifications, Division VIII - Landscaping and Restoration.

1.02 REFERENCES

- A. Michigan Department of Transportation (MDOT):
 - 1. 4.00 Construction Mix Designs.
 - 2. 4.00.04 Trench Surface Conditioning.
 - 3. 4.06.09 Application of Cover Material.
 - 4. 4.06.12 Maintenance of Surface.
 - 5. 6AA Coarse Aggregate.
 - 6. City of Ann Arbor Public Services Department, Standard Specifications.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Material Certificates: Provide copies of materials certificates signed by materials producer and CONTRACTOR, certifying that each materials item complies with or exceeds specified requirements.
- B. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

- A. Certification: CONTRACTOR shall submit certificates of compliance with applicable MDOT Standard Specifications.

1.05 WARRANTY

- A. Special Warranty: Provide, in accordance with Section 01770, warranties covering the items included under this Section.
 - 1. Warranty Period: 1 year from the time of planting.

2. This warranty includes furnishing new plants as well as labor and materials for installation of replacements. Replacement plantings shall meet or exceed all requirements for original plant materials as specified herein.
3. CONTRACTOR shall not assume responsibility for damages or loss of plants or trees caused by fire, flood, lightning storms, freezing rains, winds over 60 miles per hour, or vandalism.

PART 2 - PRODUCTS

2.01 AGGREGATE BASE

- A. Aggregate base shall be constructed with not less than 12 inches of compacted aggregate placed in two 6-inch layers. Aggregate base shall meet requirements of MDOT Specification for 21A or 22A aggregate. Aggregate base shall extend beyond pavements to match existing aggregate or a minimum of 24 inches.

2.02 AGGREGATE SURFACE

- A. Aggregate surface shall be constructed with not less than 12 inches of aggregate placed in two 6-inch layers. Aggregate surface shall meet MDOT Specification No. 22A.

2.03 GRAVEL DRIVEWAYS

- A. Gravel or dirt driveways removed shall be replaced with gravel, and shall be constructed to match existing thickness but with not less than 6 inches of gravel, compacted to 95 percent compaction. Gravel shall meet MDOT Specification No. 22A.

2.04 CONCRETE SIDEWALKS

- A. Concrete sidewalks shall be replaced with walks 4 inches thick (6 inches thick at driveway crossings) and to the same width as the existing walks. Concrete shall be Class B.

2.05 SEEDING

- A. Seeding shall be one of the following types:
 1. Sodded Shoulders, Slope Area, or Flat Field: 4 inches of topsoil, 20 pounds of 10-6-4 commercial fertilizer per 1,000 square feet of area, and 5 pounds of MDOT mixture roadside per 1,000 square feet of area.
 2. Flat Lawn Area: 4 inches of topsoil, fertilizer as specified above and 3 pounds of MDOT mixture Class A per 1,000 square feet of area.
 3. Grass Seed Mixture Requirements is included in 01110.
- B. Sod: Provide strongly rooted sod, not less than 2 years old, free of weeds and undesirable native grasses, and machine cut to pad thickness of 3/4 inch (plus or minus 1/4-inch), excluding top growth and thatch. Provide only sod capable of vigorous growth and development when planted (viable, not dormant). Peat sod will not be acceptable.
 1. Provide sod of uniform pad sizes with maximum 5 percent deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically with a firm grasp on upper 10 percent of pad will be rejected.

2. Provide sod composed principally of following:
 - a. Mixed Kentucky Bluegrass (*Poa pratensis*).

PART 3 - EXECUTION

3.01 COORDINATION OF WORK

- A. Type of restoration shall be as noted on Drawings regardless of existing surface.
- B. The placing of base and surface courses shall follow immediately after backfilling the trench so that not more than 600 feet of length of trench shall be incomplete at one time. If areas of trench in excess of 600 feet are left incomplete, CONTRACTOR shall provide such necessary temporary roadway surface as directed by ENGINEER. Any material placed in the trench other than that specified shall be considered as a temporary surface and shall be removed. No payment will be allowed for temporary roadway construction.
- C. All utilities, such as catch basins, manhole castings, water valve boxes, etc., shall be adjusted prior to installation of new pavement so that the finished surface will meet such utilities smoothly when surfacing is completed.

3.02 EXCAVATION

- A. Before repaving is started, all trenches and area around structures shall be excavated or backfilled to the level of the subgrade as required by the type of pavement replacement and cross-section specified. All existing pavement that has been undercut by the excavation for the pipe or structures shall be removed. The finished subgrade shall be smoothed, trimmed, and compacted to the required grade and cross-section. Compaction of the finish subgrade shall be obtained by suitable means approved by ENGINEER.

3.03 AGGREGATE PAVEMENTS

- A. Aggregate surfaces shall be replaced with aggregate. After placing aggregate, this surface shall immediately be opened to traffic and as holes and ruts appear, they shall be filled with aggregate and the surface shall be maintained as a smooth, dust-free street surface until Work is accepted by ENGINEER and OWNER.

3.04 CONCRETE CONSTRUCTION

- A. Sidewalks: Forms shall be of metal or wood, straight and free of distortion, and of sufficient strength to resist springing during the placing of concrete. Forms shall be securely staked, braced, and tied to the required line and grade. Flexible steel or adequately sized lumber may be used for short radius forms.
 1. The walk subgrade shall be compacted to 95 percent compaction by tamping. After wetting the subgrade, the concrete shall be placed to the proper depth and spaded along the form faces.
 2. Concrete shall be alternately tamped and screeded until all voids are removed and the surface has been brought to the required grade. The surface shall then be floated to produce a smooth, dense surface, free from irregularities. All edges and joints shall be rounded to a radius of 1/4 inch with an edging tool and trowel. As soon as all excess moisture has disappeared, the surface shall be finished by light brooming.

3. Walks shall be divided into blocks approximately square, using slab division forms or by cutting joints after floating. These joints shall be 1/2-inch-deep by 1/8- to 1/4-inch in width, and shall be finished smooth and true to line. Bituminous expansion joints shall be provided at intervals of 50 feet and at junctions with structures and curbs. Control joints shall be located between expansion joints at intervals equal to the sidewalk width.
4. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.

3.05 SEEDING

- A. Wherever the trench passes through an area to be seeded, the backfilling shall be carried up to the surface except the top 4 inches, which shall be selected topsoil preserved or secured elsewhere for this purpose. This topsoil shall be rich, black surface earth, free from sod, weed stalks, or debris. The trench surface shall be carefully raked to an even surface, and all stones, sticks and other debris removed therefrom.
- B. Seeded areas shall receive a proper mulch of chopped straw, jute matting, or woven Kraft paper yarn. Seed shall not be sown between June 15 and August 15, or between October 15 and April 15, or at any time when the soil has insufficient moisture to ensure proper germination, or CONTRACTOR shall provide sufficient application of water by sprinkling until a growing catch of grass is established.

3.06 SODDING

- A. Lay sod within 24 hours from time of stripping. Do not plant dormant sod or if ground is frozen.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.
- C. When sod is laid on slopes, the first row of sod shall be laid at the bottom of the slope parallel to it, with subsequent rows laid from bottom to top. On slopes steeper than 3:1, the sod shall be secured with pegs spaced at 2 feet maximum, vertically and horizontally.
- D. Water sod thoroughly with a fine spray immediately after planting.
- E. Sodded areas shall be kept moist for the maintenance period. After the sod is installed, all areas greater than 1 foot which fail to show a uniform stand of grass, shall be resodded.

3.07 RECONDITIONING EXISTING LAWNS

- A. Recondition existing lawn areas damaged by CONTRACTOR's operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas where minor regrading is required.
- B. Provide fertilizer, seed or sod, and soil amendments as specified for new lawns, and as required, to provide a satisfactorily reconditioned lawn.

- C. Provide new topsoil, as required, to fill low spots and meet new finish grades.
- D. Cultivate bare and compacted areas thoroughly to provide a satisfactory planting bed.
- E. Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from CONTRACTOR's operations, including oil drippings, stone, gravel, and other loose building materials.
- F. Where substantial lawn remains but is thin, mow, rake, aerate if compacted, fill low spots, remove humps, and cultivate soil, fertilize, and seed. Remove weeds before seeding, or if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.
- G. Water newly planted lawn areas and keep moist until new grass is established.

3.08 TREE REPLACEMENT

- A. Trees noted on Drawing or designated by ENGINEER to be removed shall be replaced with trees of the sizes and types listed on Tree Schedule. OWNER will decide which of the 6 types of trees shall be replaced in each location.
- B. Preparation: Tree pits shall be excavated as shown on Drawings. Subsoil dug from pits, trenches, and beds shall be disposed of by CONTRACTOR.
- C. Topsoil shall be provided in sufficient quantities to be placed:
 1. In tree pits, 6 inches in depth below the balled root and 1 foot in width around the ball.
 2. In shrub pits, 6 inches in depth below the balled or container root and 6 inches in width around it.
 3. All other planting beds shall receive a minimum of 6 inches of topsoil.
- D. Planting: CONTRACTOR is responsible for planting to correct grades and alignment and all plants shall be set so that, when settled, they will bear the same relation to finish grade as they did before being transplanted. No filling will be permitted around trunks or stems.
 1. When the plant has been properly set, the pit shall be backfilled with planting mixture, gradually filling, tamping, and settling with water. No soil in a frozen or muddy condition shall be used for backfilling. A ring of soil shall be formed around the edge of each plant to hold water.
 2. CONTRACTOR shall make adjustments in the location of plants where necessary as directed by ENGINEER.
- E. Mulching: All planting shall be mulched with a cover of shredded bark mulch.
- F. Watering: All plants shall be thoroughly soaked after planting. After each watering, all beds shall be raked and left in a complete and finished manner.
- G. Pruning and Repair: Upon completion of planting, all trees and shrubs shall have been pruned and injuries repaired. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots from transplanting. Pruning shall be done in such a manner as not to change the natural habit or shape of the plant, as directed by

ENGINEER. All cuts shall be made flush, leaving no stubs. Notify ENGINEER at least 1 week prior to pruning operations.

- H. Guying, Staking, and Wrapping Trees: Guying and staking shall be completed immediately after planting. Maintain guys and stakes until the end of the guarantee period. The trunks of all deciduous trees larger than 6 to 8 feet grade shall be wrapped with standard tree wrap from the first branch down to the ground and secured at every second wrap with twine.

3.09 PROTECTION

- A. Protection and Maintenance: CONTRACTOR shall assume responsibility for maintaining CONTRACTOR's Work to the end of the guarantee period. During this period, CONTRACTOR shall make a minimum of 1 maintenance trip every 4 weeks during the growing season, and as many more as necessary to keep the plantings in a thriving condition.
 - 1. Maintenance of plants shall consist of pruning, cultivating, weeding, watering, keeping guying taut and trees erect, raising tree balls which settle below grade, and providing such sprays as are necessary to keep the planting free of insects and diseases.
- B. Acceptance: At the end of the warranty period, final acceptance will be made by ENGINEER and OWNER, provided all requirements of the Specifications have been fulfilled.
 - 1. Inspection of the plantings will be made jointly by CONTRACTOR and ENGINEER at completion of planting. All plants not in a healthy growing condition shall be removed and replaced with plants of like kind, size, and quality as originally specified before close of next planting season.

END OF SECTION

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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.
- B. Related Sections:
 - 1. Section 02310: Earthwork for drainage fill under slabs-on-grade.

1.03 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, subject to compliance with requirements.

1.04 ACTION 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.
 - 2. Water/cement ratio (total gallons of water per cubic yard).
 - 3. Brand, type, and quantity of cement.
 - 4. Type and quantity of aggregates.
 - 5. Type and quantity of admixtures.
 - 6. Type, composition, and quantity of fly ash.
 - 7. Unit weight (wet density).
 - 8. Composition strength based on 28-day compression test.
- 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.

- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Engineer.
- F. Samples: For waterstops vapor retarder.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer manufacturer testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Fiber reinforcement.
 - 6. Waterstops.
 - 7. Curing compounds.
 - 8. Floor and slab treatments.
 - 9. Bonding agents.
 - 10. Adhesives.
 - 11. Vapor retarders.
 - 12. Joint-filler strips.
 - 13. 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. Submit laboratory test reports for concrete mix design, aggregates (particularly deleterious materials in coarse aggregate) and fly ash (if used) 4 weeks before scheduled pouring.
 - 1. For mass concrete, submit laboratory test report on the heat of hydration for the trial mix design if requested by Engineer. Trial mix design shall consist of concrete block 4-foot by 4-foot by 4-foot.
- F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

- G. Field quality-control reports.
 - 1. Submit written reports to Engineer documenting testing and inspection results.
 - 2. Submit mill test reports on reinforcement.
 - 3. Submit materials certificates in lieu of laboratory test reports on other materials. Manufacturer and Contractor shall sign material certificates certifying that each material item complies with, or exceeds, specified requirements. Submit certification from admixture manufacturers that chloride content complies with specification requirements.

- H. Minutes of preinstallation conference.

1.06 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/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

- 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/D 1.4M, "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," Sections 1 through 5.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

- 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.
 - e. Special concrete finish subcontractor.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi rigid joint fillers, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1.08 PROJECT CONDITIONS

- A. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS

2.01 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. High-density overlay, Class 1 or better.
 - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - c. Structural 1, B-B or better; mill oiled and edge sealed.
 - d. 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. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- E. 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.
- F. 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 (25 mm) to the plane of exposed concrete surface.
 - 2. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- C. Deformed-Steel Wire: ASTM A 496/A 496M.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

2.03 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), 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.

2.04 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, except use Type III where applications require high-early-strength or Type II where required by Engineer for corrosive environments.
 - 2. Use one brand of cement throughout Project, unless otherwise acceptable to Engineer.
- B. Fly Ash: ASTM C 618, Type C or Type F (corrosive environments) with loss on ignition not more than 6 percent.
- C. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Water: ASTM C 94/C 94M.
- E. Potable Water Structures: For surfaces in contact with potable water, use only materials approved by Department of Public Health of the state that has jurisdiction.

2.05 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions.
 - 2. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. Water Reducing, Nonchloride Accelerator Admixture: ASTM C 494, Type E.
 - 6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

2.06 FIBER REINFORCEMENT

- A. Synthetic Micro-Fiber: Monofilament polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 1/4 inches (25 to 57 mm) long.
 - 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. Monofilament Micro-Fibers:
 - 1) Axim Italcementi Group, Inc.; Fibrasol II P.
 - 2) Euclid Chemical Company (The), an RPM company; Fiberstrand 150.
 - 3) FORTA Corporation; FORTA Econo-Mono.
 - 4) Grace Construction Products, W. R. Grace & Co.; Grace MicroFiber.
 - 5) Metalcrete Industries; Polystrand 1000.
 - 6) Nycon, Inc.; ProConM.
 - 7) Propex Concrete Systems Corp.; Fibermesh 150.
 - 8) Sika Corporation; Sika Fiber PPM.

2.07 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Fortifiber Building System
 - 2. Raven Industries, Inc.
 - 3. Stego Industries, LLC
- B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick.

2.08 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

2.09 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. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- C. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) 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 (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) 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 (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixes for each concrete class and strength by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method is used, use independent testing facilities acceptable to Engineer for preparing and reporting proposed mix designs. Testing facility shall not be identical to that used for field quality control testing.
- B. Fly ash shall be used to partially supplant cement content in Class A and Class S concrete, unless noted otherwise, and is optional in other classes. Replacement quantity of cement content by weight shall be not less than 15 percent for Class A and Class S concrete or more than 25 percent for all classes except Class F.
- C. For concrete Class A and Class S, concrete mix design with fly ash shall be maximum 30 percent of cement content by weight, and shall constitute no more than 20 and 10 percent, respectively, of the total weight of cementitious materials.
- D. For concrete, Class S, use Portland cement Type II with fly ash, Type F.
- E. Coarse aggregate shall be 1-1/2" top size, except for Class G concrete which shall be 3/8" top size.
- F. Design mixes to provide normal weight concrete for following classes and properties:
 1. Locations for concrete classes are as follows:
 - a. Class A Structural concrete (slabs, walls, columns, beams, equipment bases, electrical duct banks, and slab toppings 2 inches or greater in thickness). Note: High range water-reducing admixture shall be used for all concrete walls

- b. Class S Sulfate resistant structural concrete (slabs, walls, columns, and beams) where indicated on Drawings.
- c. Class G Grout fill for use in sweeping in final surfaces in sanitary structures and slab toppings less than 2 inches in thickness.
- d. Class P Exterior pavements (unless otherwise indicated on Drawings).
- e. Class B Sidewalks and manhole bases (unless otherwise indicated on Drawings).
- f. Class C Fill within manholes, mud mats, fill under structures, encasement for piping below or adjacent to structures and encasement for floor drains, sewer inlets and similar items.
- g. Class F Flowable fill for filling spaces as permitted and directed by Engineer.

2. Properties for concrete classes are as follows:

Concrete Class		A	S	G	P	B	C	F
28-Day* Compressive Strength (f'c), psi		4,000	5,000	4,000	3,500	3,000	2,000	50-100
Cement Content per cubic yard of concrete, sacks minimum **		6	7	6	5.5	5	4	0.4-3.0
Water/Cement Ratio by weight, maximum		0.44	0.40	0.44	0.44	0.58	0.75	0.40-0.75
Air Content, percent by volume		6±1	<4	6±1	6.5±1.5	6.5±1.5	NA	NA
Slump at point of placement, inches.	WR***	2-4	2-4	2-4	2-4	3-5	3-6	NA
	MRWR	4-6	4-6	4-6	4-6	NA	NA	NA
	HRWR****	6-8	6-8	6-8	6-8	NA	NA	NA
Monofilament Polypropylene, Type F1		Yes	Yes	Yes	Yes	Yes	NA	NA

* 7-day compressive strength for high-early-strength concrete.

56-day compressive strength for mass concrete

** For concrete with fly ash, values are total of cement plus fly ash (except Class F concrete).

*** Slump prior to the addition of mid-range or high-range water reducers.

**** High range water-reducing admixture shall be used for all concrete walls.

- 3. Adjustment of Concrete Mixes: Mix designs may be adjusted when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, when approved by Engineer, at no additional cost to Owner. Submit laboratory test data for revised mix design and strength results to Engineer before using in work.
- 4. Admixtures:
 - a. Use water-reducing admixture or high range water-reducing admixture (superplasticizer) in concrete for placement and workability.
 - b. Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F (10 degrees C).

- c. Add air-entraining admixture at manufacturer's prescribed rate to result in placed concrete having total air content specified.
- d. Use nonstructural synthetic reinforcement, monofilament polypropylene Type F1 in Class A concrete for exposed exterior surfaces without earth covering, and as specified by Engineer for other concrete mix design. Bottom slabs of open concrete tanks do not require synthetic reinforcement. The synthetic reinforcing fibers shall be added to the concrete mix at the rate of 1.5 pounds per cubic yard and in accordance with manufacturer's recommendations.

2.12 FABRICATING REINFORCEMENT

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

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.
- B. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 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 (3.2 mm) for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch (6 mm) 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.

3.02 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.

3.03 REMOVING AND REUSING FORMS

- A. Vertical Forms not supporting concrete weight may be removed when concrete has sufficiently set to resist damage from removal operation.
- B. Other forms shall be left in place until concrete has attained strength to support its own weight and construction live loads, unless removed in sections, and each structural section immediately reshored.
- C. Time Periods: Forms remain in place as shown in table below. If form removal occurs before time shown in the table, apply curing procedures previously specified.

Minimum Time Forms are to Remain in Place:

Part of Structure	Average Air Temperature* During Period	
	40 - 50 degrees F	50 degrees F
Walls, columns and sides of beam (hours)	72	24
Bottom forms for slabs, beams arches not reshored (days)	12	7
Bottom forms for slabs, beams and arches if reshored (days)	7	4

* Air temperature near form.

- D. 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.
- E. 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.

3.04 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

3.05 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.
- 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. Field bending of reinforcement:
 - 1. Field bending of plain reinforcement shall be performed using an approved and appropriate sized portable hydraulic device that makes ACI-approved radius bends. No other field bending method shall be permitted.
 - 2. No field bending shall be permitted for epoxy coated reinforcement.

3.06 JOINTS

- A. Locate and install construction joints as shown or, if not shown, locate so as not to impair strength and appearance of structures, at intervals not to exceed 50 feet. For construction joints in water-containing structures or tanks or in water-restraining structures, use watertight joints.
- B. Continue reinforcement across construction joints, unless otherwise noted. Mechanical inserts with threaded studs are not accepted as substitutes for through-dowels.
- C. Locate construction joints in floor system at or near middle of span in slabs, beams, or girders unless beam intersects girders at this point. Then, where not shown on Drawings, joints in girders shall be offset distances twice the width of beams, and provisions made for shear by web reinforcement across joints.
- D. Provide watertight joints to prevent water seepage. Take special care in finishing surfaces to which succeeding concrete is bonded. Provide waterstops in joints if shown. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops according to manufacturer's printed instructions.
- E. Provide isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces of column pedestals, foundation walls, and grade beams.
- F. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction (control) joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 3/16 inch by 1/4 slab depth or inserts 1/4-inch wide by 1/4 of slab depth unless otherwise noted.
- G. If joint pattern is not shown, provide joints at 15 feet at most in either direction, with locations to conform to bay spacing wherever practical (at column centerlines, half-bays, third-bays).
- H. Form contraction joints by inserting pre-molded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

- I. Cut contraction joints in unexposed floor slabs by saw cuts as soon as practical after slab finishing when it can be safely done without dislodging aggregate.
- J. 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.

3.07 INSTALLATION OF EMBEDDED ITEMS

- A. Set and build into Work anchorage devices and other embedded items required for other work that are attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of attachment items.
- B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain set elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support screed strips by use of strike-off templates or accepted compacting screeds.
- C. Conduits and pipes of aluminum shall not be embedded in structural concrete unless they are effectively coated or covered to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

3.08 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with form-coating compounds before placing reinforcement.
- C. Thin form-coating compounds only with acceptable thinning agents, quantity, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete is placed. Apply in compliance with manufacturer's instructions.
- D. Coat steel forms with non-staining, rust-preventive form oil to protect against rusting. Rust-stained steel formwork is not acceptable.

3.09 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, reinforcing steel, waterstop installation, and other embedded or cast-in items.
 - 1. Notify other crafts to permit installation of their work.
 - 2. Cooperate with other trades in setting their work.
 - 3. Moisten wood forms immediately before placing concrete where form coatings are not used.

4. Apply temporary protective covering to lower 2 feet of finished walls where adjacent floor slabs are poured to guard against spattering during slab placement.
- B. Comply with ACI 304R and as specified in this Section.
 - C. Discharge Concrete at Site within 1-1/2 hours after cement is added to water or aggregates. When air temperature exceeds 85 degrees F, the discharge time shall be less than 45 minutes. The 45-minute requirement may be waived with the use of a water reducing, retarding admixture and approval of Engineer.
 - D. Provide trip ticket in duplicate for each ready-mixed concrete load delivered, stating truck number, Project name, Contractor and producer, batching time, total yards of concrete and material contained therein. Show ticket to Engineer upon request. Fill in concrete discharge time and turn over to Engineer trip ticket copies at end of each day.
 - E. Deposit concrete continuously or in layers so that no concrete is placed on concrete which has hardened sufficiently to cause seams or planes of weakness. If section cannot be placed continuously, provide construction joints as specified. Deposit concrete as nearly as practical to its final location to avoid segregation.
 - F. When depositing by chute, provide equipment of size and design to ensure continuously flowing concrete. Provide discharge end of chute with baffle plate to prevent segregation. Position chute so that concrete need not flow more than 5 feet horizontally.
 - G. Do not drop concrete from chute end distances greater than 3 times the deposited layer thickness, nor more than 5 feet. Where distance from chute end to surface of concrete exceeds these distances, use spout and maintain lower end as near to deposit surface as practical. When operations are intermittent, discharge chutes into hoppers.
 - H. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24 inches to avoid inclined construction joints. Where placement involves several layers, place each layer while preceding layer is still plastic to avoid cold joints.
 1. Fill bottom of wall space with 2 to 4 inches of cement slurry immediately before depositing concrete in walls. Use cement slurry composed of 1 part Portland cement, 2 parts fine aggregate, and sufficient water (but not to exceed 0.45 parts) for 7-inch slump mixture.
 2. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures for concrete consolidation in accordance with ACI recommended practices.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible machine effectiveness. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into concrete layers that have begun to set. At each insertion, limit duration to time necessary to consolidate concrete and complete reinforcement embedment and other embedded items without causing mix segregation. Keep vibrators away from waterstops to prevent displacement.

- I. Placing Concrete Slabs: Deposit and consolidate concrete slabs in continuous operations between construction joints until panel or section placement is complete.
 - 1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces before beginning finishing operations.
 - 3. Maintain reinforcing in proper position during concrete placement operations.
 - 4. Maintain waterstop in proper position during concrete placement operations.
 - 5. Concrete Placement against Expanding Bentonite Waterstop. Direct concrete flow away from bentonite water stops. If flow cannot be away from bentonite, direct flow parallel to waterstop.
 - 6. Moisten soil when depositing concrete directly on granular soil.

- J. 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 bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

- K. 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 (4.4 deg C) 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.

- L. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. Maintain concrete temperature below 90 deg F (32 deg C) 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.

3.10 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.
- C. 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.

3.11 FINISHING FLOORS AND SLABS

- A. Trowel Finish: Apply trowel finish to monolithic slab surfaces exposed-to-view, and slab surfaces covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
 - 1. After floating, begin first trowel finish operation using power-driven trowels. Begin last troweling when surface produces ringing sound when trowel moves over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance.
 - 2. Check and level surface plane to tolerances of floor flatness (FF) of 20 and floor levelness (FL) of 17 in accordance with ASTM E 1155.
 - 3. Grind smooth surface defects that would telegraph through applied floor covering system.
- B. Nonslip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, ramps, and elsewhere as noted.
 - 1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required finish with Engineer before application.

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:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 2. Construct concrete bases 4 inches ((100 mm)) high unless otherwise indicated; and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
 3. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete substrate.
 6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported 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. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Start curing as soon as free water has disappeared from concrete surface after placing and finishing. Maintain curing as follows:
1. All concrete unless otherwise noted: 7 days.
- C. Curing Methods: Cure concrete for structures by moist curing.
- D. Provide Moist 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 cover concrete surfaces and edges, with 4 inches lap over adjacent absorptive covers.
- E. Provide Moisture-Retaining Cover Curing as follows:
1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped 3 inches and sealed by waterproof tape or adhesive.
 2. Immediately repair holes or tears during curing period using cover material and waterproof tape.

- F. Curing Formed Surfaces: Cure formed concrete surfaces, including beam undersides, supported slabs and other similar surfaces by moist curing with forms in place for full curing period. If form removal occurs before curing period is up, continue curing by methods specified above as applicable.
- G. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

3.14 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 one month. 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 (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer'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 (1.18-mm) 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 (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). 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 Engineer.

- 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 (0.25 mm) 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 (6 mm) 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 (25 mm) 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 (19-mm) 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 (25 mm) 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 Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.16 FIELD QUALITY CONTROL

- A. Testing and Inspecting: The Contractor shall hire a testing agency to perform field tests and inspections and prepare test reports.
- B. Provide qualified personnel and employ testing laboratory, approved by Engineer, to do tests and to submit test reports.

- C. Sampling Fresh Concrete: ASTM C 172, except modified for slump and air-content tests to comply with ASTM C 94.
1. Slump: ASTM C 143, one each time compression test specimens are made; additional tests when concrete consistency seems to have changed.
 2. Air Content: ASTM C 231, pressure method, one each time compression test specimens made.
 3. Concrete Temperature: Test hourly when air temperature is 40 degrees F and below, and when 80 degrees F and above; and each time compression test specimens are made.
 4. Compression Test Specimen: ASTM C 31, four standard cylinders for each compressive strength test set, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens.
 5. Compressive Strength Tests: Coordinate with requirements in section 01450. ASTM C 39; 1 specimen tested at 7 days, 2 specimens tested at 28 days, and 1 specimen retained in reserve for later testing if required.
- D. Test Results: Report test results in writing to Engineer and Contractor within 24 hours after tests. Compressive strength test reports shall contain Project identification name and number, concrete placement date, concrete testing service name, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and break type for both 7-day tests and 28-day tests.
- E. Acceptance: Concrete strength shall be considered satisfactory if averages of 3 consecutive strength test results equal or exceed specified 28-day compressive strength ($f'c$), and no individual strength test result falls below specified compressive strength by more than 500 psi.
- F. Failure to Meet Requirements:
1. Should 7-day compressive strengths shown by test specimens fall below 65 percent of required 28-day strength ($f'c$), Engineer will have the right to require changes in proportions for remaining Work. Furthermore, Engineer will have the right to require additional curing, as specified in this Section, on those portions or structures represented by failed test specimens.
 2. Should 28-day compressive strengths ($f'c$) test results fail to meet required strength, core-boring tests conforming to ASTM Standard C 42 shall be made at Contractor's expense within 60 days of that concrete placement.
- G. At locations where concrete quality is deemed questionable by Engineer, core-boring tests shall also be made at Contractor's expense.
- H. Concrete is acceptable if average strength of 3 cores is at least 85 percent and no single core is less than 75 percent of required minimum allowable 28-day compressive strengths ($f'c$). If core-boring test results fail to meet strength requirements, Engineer will have right to require strengthening or replacing those portions of structures which failed to develop specified strength.

- I. Provide additional curing when ordered by Engineer because of failure to meet requirements. It shall be done at Contractor's expense, and no claim for extra compensation for additional curing will be allowed. Additional curing shall extend period of protection. Additional curing is limited to 60 days.
- J. Additional Tests: Testing service shall make additional in-place concrete tests when test results suggest specified concrete strengths and other characteristics have not been attained. Testing service may conduct tests to determine adequacy by cored cylinders complying with ASTM C 42, or by other approved methods. Contractor shall pay for additional tests when unacceptable concrete is verified.

END OF SECTION

SECTION 04200 - UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section includes the following:
 - 1. Concrete unit masonry.

1.02 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following installed compressive strengths (f'm):
 - 1. For concrete unit masonry:
 - a. f'm = 1,500 pounds per square inch.
 - b. As indicated on structural Drawings.

1.03 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Submittals shall be issued in an electronic format. Comments will be returned in an electronic format.
- B. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.
 - 1. Block data required consists of the following:
 - a. Block grade.
 - b. Block type.
 - c. Weight classification.
 - d. Material test data:
 - 1) Minimum compressive strength.
 - 2) Maximum water absorption (percent).
 - 3) Moisture content percent total absorption.
 - 4) Linear shrinkage percent.
 - e. Material Certificate of Compliance
 - f. Proof of compliance of 30-day curing period.
 - 1) Date of manufacture.
 - 2) Date of shipping.
 - 2. Mortar data required consists of the following:
 - a. Mortar.
 - b. Method of manufacture (proportion or property).
 - c. Material test data:
 - 1) Aggregate for mortar (ASTM C 144 with no exceptions to gradation limits).
 - 2) Mortar composition and properties (ASTM C 780) Proportion Method.
 - 3) Mortar properties (ASTM C 270) Property Method.
 - d. Material Certificate of Compliance.

3. Grout data required consists of the following:
 - a. Grout Mixes: Include description of type and proportion of grout ingredients.
 - b. Material test data: Compressive strength (ASTM C 1019).
 - c. Material Certificate of Compliance.
 4. Joint reinforcement, ties, anchors, and flashing:
 - a. Manufacturer's literature.
 - b. Material Certificate of Compliance.
- C. Shop Drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315, Details and Detailing of Concrete Reinforcing, showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement. Include special reinforcement required for openings through masonry structures.
- D. Samples for initial selection purposes of the following:
1. Unit masonry samples in small-scale form showing full extent of colors and textures available for each different exposed masonry unit required.
 - a. Submit a minimum of 18 standard or custom colors for CMU color selection.
- E. Quality Assurance Submittals:
1. Material certificates shall be signed by manufacturer and CONTRACTOR, certifying that each material complies with requirements.
 2. Material test reports shall be from a qualified independent testing laboratory employed and paid by CONTRACTOR indicating and interpreting test results relative to compliance of the masonry materials with requirements:
 3. Cold weather construction procedures evidencing compliance with requirements specified in "Project Conditions" paragraph of this Section.
 4. Hot weather construction procedures evidencing compliance with requirements specified in "Project Conditions" paragraph of this Section.
 5. Qualification data for CONTRACTORS, firms, and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include list of completed projects with project name, address, telephone number, names of ENGINEERS and OWNERS, and other information specified.
 6. Results from tests and inspections performed by OWNER's Representatives shall be reported promptly and in writing to ENGINEER and CONTRACTOR.

1.04 QUALITY ASSURANCE:

- A. Unit Masonry Standard: Comply with ACI 530.1/ASCE 6, Specifications for Masonry Structures, except as otherwise indicated.
- B. A qualified Professional ENGINEER must inspect foundations for compliance with dimensional tolerances specified in referenced unit masonry standard, prior to masonry wall construction.
 1. ENGINEER Qualifications: Professional ENGINEER legally authorized to practice surveying in jurisdiction where Project is located.

- C. Masonry CONTRACTOR Qualifications: The masonry CONTRACTOR shall submit in writing 5 projects of similar size and construction type to exhibit the experience level necessary to perform the Work. List project location, size, wall construction type, OWNER contact, and telephone number.
- D. Masonry Inspection:
 - 1. Prism Tests: For each type of wall construction indicated, masonry prisms shall be tested per ASTM C 1314.
 - 2. Grout compressive strength will be tested per ASTM C 1019 for property specification and C 476 for proportion specification.
- E. Single Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a 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.
- F. Single Source Responsibility for Mortar Materials: 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.
- G. Pre-installation Conference: Conduct conference at Site to comply with requirements of Section 01200, Project Meetings.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver masonry materials to Site in undamaged condition.
- B. Store and handle masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.
- C. Store cementitious materials off the ground, under cover, and in dry location.
- D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.06 PROJECT CONDITIONS:

- A. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each workday. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours, and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that come in contact with such masonry.
1. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and doorframes, as well as similar products with painted and integral finishes from mortar droppings.
- D. Cold Weather Construction:
1. Perform the following construction procedures while Work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation, except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 10 degrees F (6 degrees C).
 2. 40 degrees F (4 degrees C) to 32 degrees F (0 degrees C):
 - a. Mortar: Heat mixing water to produce mortar temperature between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).
 - b. Grout: Follow normal masonry procedures.
 3. 32 degrees F (0 degree C) to 25 degrees F (-4 degrees C):
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 4. 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 - c. Heat both sides of walls under construction using salamanders or other heat sources.
 - d. Use windbreaks or enclosures when wind is in excess of 15 miles per hour.
 5. 20 degrees F (-7 degrees C) and below:
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).
 - b. Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of workday.
 - c. Masonry Units: Heat masonry units so that they are above 20 degrees F (-7 degrees C) at time of laying.
 - d. Provide enclosure and auxiliary heat to maintain an air temperature of at least 40 degrees F (4 degrees C) for 24 hours after laying units.

6. Do not heat water for mortar and grout to above 160 degrees F (71 degrees C).
 7. Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry temperature ranges apply to anticipated minimum night temperatures.
 8. 40 degrees F (4 degrees C) to 32 degrees F (0 degree C):
 - a. Protect masonry from rain or snow for at least 24 hours by covering with weather-resistant membrane.
 9. 32 degrees F (0 degree C) to 25 degrees F (-4 degrees C):
 - a. Completely cover masonry with weather-resistant membrane for at least 24 hours.
 10. 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):
 - a. Completely cover masonry with weather-resistant insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
 11. 20 degrees F (-7 degrees C) and below:
 - a. Except as otherwise indicated, maintain masonry temperature above 32 degrees F (0 degree C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps, or other methods proven to be satisfactory. For grouted masonry, maintain heated enclosure to 40 degrees F (4 degrees C) for 48 hours.
 12. Do not lay masonry units that are wet or frozen.
 13. Remove masonry damaged by freezing conditions.
- E. Hot Weather Construction: When the ambient air temperature exceeds 100 degrees F or 90 degrees F with a wind velocity greater than 8 miles per hour, do not spread mortar beds more than 4 feet ahead of masonry. Set masonry units within 1 minute of spreading mortar.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

2.02 MATERIALS:

- A. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.

2.03 CONCRETE MASONRY UNITS

- A. Comply with requirements indicated below applicable to each form of concrete masonry unit required.
 1. Provide 2-core, plain-end units for walls vertically reinforced.
 2. Provide special shapes where indicated and as follows:
 - a. For lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
 - b. Bullnose units for outside corners of interior work only unless otherwise indicated.
- B. Concrete Block: Provide units complying with characteristics indicated below for grade, face size, exposed face and, under each form included, for weight classification.

1. Normal-weight Units: Normal-weight units shall be used for exterior walls below grade and exterior units of single- and multi-wythe walls above grade. Units shall be Grade N, manufactured from normal weight aggregates conforming to ASTM C 90.
 2. Size: Provide concrete masonry units complying with requirements indicated below for size, that are manufactured to specified face dimensions within tolerances specified in the applicable referenced ASTM specification for concrete masonry units.
 - a. Concrete Masonry Units: Manufactured to specified dimensions of 3/8 inch less than nominal widths by nominal heights by nominal lengths indicated on Drawings.
 3. Provide Cured Units: Manufacturer must store units outside after manufacture a minimum of 30 days under a covered storage area to protect the units from additional moisture during the curing (drying) process.
 4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
 5. Integral Water Repellent Admixture: An integral liquid polymer admixture mixed with concrete during production of the CMU which cross-links and becomes permanently locked into the CMU, bond beam, or CMU lintel to provide resistance to water penetration to achieve a Class E rating when tested in accordance with ASTM E 514-74.
- C. Hollow Load-Bearing Concrete Masonry Units: ASTM C 90, Grade N, and as follows:
1. Unit Compressive Strength: Provide units with minimum average net area compressive strength indicated below:
 - a. 1,900 pounds per square inch.
 2. Weight Classification:
 - a. Normal weight (greater than 125 pounds per cubic foot concrete).

2.04 MORTAR AND GROUT MATERIALS:

- A. Mortar and Grout
 1. Compressive Strength: 2,000 pounds per square inch.
- B. Portland Cement: ASTM C 150, Types I or II, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce required mortar color.
- C. Masonry Cement: ASTM C 91:
 1. For colored pigmented mortars use pre-mixed colored masonry cements of formulation required to produce color indicated or, if not indicated, as selected from manufacturer's standard formulations.
- D. Hydrated Lime: ASTM C 207, Type S.
- E. Aggregate for Mortar: ASTM C 144 with the following exceptions:
 1. Delete gradation limit waiver as described in Article 4.4.
 2. For joints less than 1/4 inch, use aggregate graded with 100 percent passing the No. 16 sieve.
 3. Colored Mortar Aggregates: Ground marble, granite, or other sound stone, as required to match ENGINEER's sample.
- F. Aggregate for Grout: ASTM C 404.

- G. Integral Water Repellent Admixture for Mortar and Grout: An integral liquid polymer admixture designed specifically for use in a mortar mix, which cross-links and becomes permanently locked into mortar to provide resistance to water penetration to achieve a Class E rating when tested in a wall section in accordance with ASTM E 514-74.
- H. Water: Clean and potable.

2.05 REINFORCING STEEL

- A. Provide reinforcing steel complying with requirements of referenced unit masonry standard and this Article.
- B. Steel Reinforcing Bars: Material and grade as follows:
- C. Deformed Reinforcing Wire: ASTM A 496.
- D. Plain Welded Wire Fabric: ASTM A 185.

2.06 JOINT REINFORCEMENT:

- A. Provide joint reinforcement complying with requirements of referenced unit masonry standard and this Article, formed from the following:
 - 1. Hot-Dip Galvanized Steel Wire: ASTM A 82 for uncoated wire, and with ASTM A 153, Class B-2 (1.5 ounces per square foot of wire surface) for zinc coating applied after pre-fabrication into units.
 - a. Application: Exterior and interior walls.
- B. Description: Welded-wire units pre-fabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, with pre-fabricated corner and tee units, and complying with requirements indicated below:
 - 1. Wire Diameter for Side Rods: 0.1483 inch (9 gauge).
 - 2. Wire Diameter for Cross Rods: 0.1483 inch (9 gauge).
 - 3. For single-wythe masonry, provide type as follows with single pair of side rods:
 - a. Ladder design with continuous diagonal cross rods spaced not more than 16 inches on center.

2.07 TIES AND ANCHORS:

- A. Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standard and of this Paragraph.
 - 1. Zinc Coated (Galvanized) Steel Sheet: Carbon steel with zinc coating complying with ASTM A 525, Coating Designation G90.
 - a. Application: Use for dovetail slots and where indicated.
 - 2. Hot-Dip Galvanized Carbon Steel Sheet: ASTM A 366, Class 2, or ASTM A 635; hot-dip galvanized after fabrication to comply with ASTM A 153, Class B.
 - a. Application: Use for anchors.
- B. Steel Plates and Bars: ASTM A 36, hot-dip galvanized to comply with ASTM A 123 or ASTM A 153, Class B3, as applicable to size and form indicated.

2.08 RIGID ANCHORS:

- A. Provide straps of form and length indicated, fabricated from metal strips of following width and thickness.
 - 1. 1-1/2 inches wide by 1/4-inch thick.

2.09 MISCELLANEOUS ANCHORS:

- A. Unit Type Masonry Inserts in Concrete: Cast iron or malleable iron inserts of type and size indicated.

2.10 MASONRY CLEANERS:

- A. Job-Mixed Detergent Solution: Solution of trisodium phosphate (1/2-cup dry measure) and laundry detergent (1/2-cup dry measure) dissolved in 1 gallon of water.

2.11 MORTAR AND GROUT MIXES:

- A. Do not add admixtures, including air-entraining agents, accelerators, retarders, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification for job-mixed mortar and ASTM C 1142 for ready-mixed mortar, of types indicated below.
 - 1. Limit cementitious materials in mortar to Portland/masonry cement.
 - 2. For masonry below grade and in contact with earth, and where indicated, use type indicated below:
 - a. Type S.
 - b. Type M.
 - 3. For reinforced masonry use type indicated below unless otherwise indicated on Drawings:
 - a. Type S.
 - b. Type M.
 - 4. For exterior, above-grade load-bearing and non-load-bearing walls and parapet walls, for interior load-bearing walls, for interior non-load-bearing partitions, and for other applications where another type is not indicated, use type indicated below:
 - a. Type S.
- D. Grout for Unit Masonry: Comply with ASTM C 476 and referenced unit masonry standard.

2.12 SOURCE QUALITY CONTROL

- A. Concrete Masonry Unit Tests: For each type, class, and grade of concrete masonry unit indicated, units will be tested by qualified independent testing laboratory for strength, absorption, and moisture content per ASTM C 140.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance of unit masonry.
- B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

- A. Deliver anchorage items which are to be embedded in other construction before start of such work. Provide setting diagrams, templates, instructions, and directions as required for installation.
- B. Comply with referenced unit masonry standard and other requirements indicated applicable to each type of installation included in Project.
- C. Do Not Wet concrete masonry units.
- D. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units using units of nominal thickness indicated.
- E. When vertical reinforcement is called for, mortar face shell and web of cores containing grout and reinforcing bars.
- F. F. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 8 inches of masonry between chase or recess and jamb of openings and between adjacent chases and recesses. Masonry directly above chases or recesses wider than 12 inches shall be supported on lintels.
- G. Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.
- H. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.
- I. No masonry shall be supported on wood girders or other form of wood construction.

3.03 CONSTRUCTION TOLERANCES:

- A. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4 inch in 10 feet, or 3/8 inch in a story height not to exceed 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/8 inch in any story or 20 feet maximum, or 1/4 inch in 40 feet or more. For vertical alignment of head joints, do not exceed plus or minus 1/4 inch in 10 feet, 3/8 inch maximum.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in any bay or 20 feet maximum, or 1/2 inch in 40 feet or more. For top surface of bearing walls do not exceed 1/8 inch between adjacent floor elements in 10 feet or 1/16 inch within width of a single unit.
- C. Variation of Linear Building Line: For position shown in plain and related portion of columns, walls, and partitions, do not exceed 3/8 inch in any bay, or 20 feet maximum, or 3/4 inch in 40 feet or more.
- D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/8 inch or plus 1/8 inch.
- E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 3/8 inch. Do not exceed head joint thickness indicated by more than plus or minus 1/8 inch.

3.04 LAYING MASONRY WALLS:

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.
- B. Lay up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
- D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- E. Stopping and Resuming Work: In each course, rack back 1/2-unit length for 1/2 running bond or 1/3-unit length for 1/3 running bond; do not tooth. 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.

- F. Built-In Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
 - 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
 - 2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
 - 3. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.05 MORTAR BEDDING AND JOINTING:

- A. Lay hollow concrete masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
- B. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
- C. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

3.06 CAVITIES/AIR SPACES:

- A. Keep cavities/air spaces clean of mortar droppings and other materials during construction. Strike joints facing cavities/air spaces flush.
- B. Tie exterior wythe to backup with continuous horizontal joint reinforcing.

3.07 CAVITY WALL AND MASONRY CELL INSULATION:

- A. On units of plastic insulation, install small pads of adhesive spaced approximately 1'-0" on center both ways on inside face, or attach to inside face with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 - 1. Fill all cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.08 HORIZONTAL JOINT REINFORCEMENT:

- A. Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcing a minimum of 6 inches.
- B. Space continuous horizontal reinforcement as follows:
 - 1. For multi-wythe walls (solid or cavity) where continuous horizontal reinforcement acts as structural bond or tie between wythes, space reinforcement as required by Code but not more than 16 inches on center vertically.
 - 2. Reinforce masonry openings greater than 1'-0" wide with horizontal joint reinforcement placed in 2 horizontal joints approximately 8 inches apart immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints.

3. Cut or interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
4. Provide continuity at corners and wall intersections by use of prefabricated L- and T-sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.09 MOVEMENT (CONTROL AND EXPANSION) JOINTS:

- A. Install control and expansion joints in unit masonry where indicated. Build in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 1. Fit bond breaker strips into hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces.
- C. Build in horizontal pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting nonmetallic 50 percent compressible joint filler of width required to permit installation of sealant and backer rod specified in Section 07900, Joint Sealers.
 1. Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.10 LINTELS:

- A. Install steel lintels above all masonry openings; size of steel lintel shall be per Lintel Schedule on Drawings.
 1. Lintels at CMU backup shall be precast concrete lintels as indicated by the drawings. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.11 FLASHING:

- A. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
- B. Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive/sealant/tape as recommended by flashing manufacturer before covering with mortar.
- C. Install Flashings as follows:
 1. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches, and through the inner wythe to within 1/2 inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.
 2. At heads and sills, extend flashing as specified above unless otherwise indicated but turn up ends not less than 2 inches to form a pan.
 3. Turn down sheet metal flashings at exterior face of masonry to form drip.
 4. Cut off concealed flashing flush with face of wall after masonry wall construction is completed.

3.12 INSTALLATION OF REINFORCED UNIT MASONRY AND BOND BEAMS:

- A. Install reinforced unit masonry to comply with requirements of referenced unit masonry standard.
- B. Temporary Formwork: Construct formwork and shores to support reinforced masonry elements during construction.
 - 1. Construct formwork to conform to shape, line, and dimensions shown. Make sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
- C. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
- D. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- E. Lay CMU units with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross-webs of starting courses in mortar. Maintain head and bed joint widths shown, or if not shown, provide 3/8-inch joints.
- F. Where solid CMU units are shown, lay with full mortar head and bed joints.
- G. Lap all splices in horizontal and vertical reinforcing bars at least 48 bar diameters unless otherwise required by governing Building Code.
- H. Reinforcing bars shall have a minimum clear spacing from inside face of masonry core of a minimum of 1 inch.
- I. Clean reinforcement loose rust, mill scale, earth, ice, or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on Drawings or final Shop Drawings, or bars with reduced cross-section due to excessive rusting or other causes.
- J. Position reinforcing accurately at the spacing indicated. Support secure vertical bars against displacement. Horizontal reinforcing shall be placed as the masonry work progresses. Where vertical bars are shown in close proximity, provide a clear distance between bars of not less than the nominal bar diameter or 1 inch (whichever is greater).

- K. Field Adjustments: If it is necessary to move bars to avoid interference with other reinforcing steel, conduits, or embedded items, and bars are moved more than 1 bar diameter or enough to exceed the specified tolerances, ENGINEER shall be notified and the resulting arrangement of bars shall be subject to acceptance.
- L. Walls:
1. Pattern Bond: Lay CMU wall units in 1/2 running bond with vertical joints in each course centered on units in courses above and below unless otherwise indicated. Bond and interlock each course at corners and intersections. Use special shaped units where shown and as required for corners, jambs, sash, control joints, lintels, bond beams, and other special conditions.
 2. Maintain vertical continuity of core or cell cavities which are to be reinforced and grouted to provide minimum clear dimension indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
 3. Where horizontal reinforced beams (bond beams) are shown, use special units or modify regular units to allow for placement of continuous horizontal reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells of non-reinforced vertical cells, or provide units with solid bottoms.
 4. Grout fill cores of block wall 2 courses below each bond beam supporting roof, floor, and other structural members. Place metal lath under lowest block to be grouted to confine grout pour.
 5. Install two No. 5 vertical bars on each side of all masonry openings extending from 1 inch below lintel bearing point to 2'-0" below the bottom of the window opening unless otherwise indicated on structural Drawings.
- M. Grouting:
1. Use "Fine Grout" per ASTM C 476 for filling spaces less than 4 inches in one or both horizontal directions.
 2. Use "Coarse Grout" per ASTM C 476 for filling 4-inch spaces or larger in both horizontal directions.
 3. Grouting Technique: At CONTRACTOR's option, use either low-lift or high-lift grouting techniques subject to requirements which follow.
- N. Low-Lift Grouting:
1. Provide minimum clear dimension of 2 inches and clear area of 8-square-inch in vertical cores to be grouted.
 2. Place vertical reinforcement prior to laying of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters or 10 feet.
 3. Lay CMU to maximum pour height. Do not exceed 5-foot height, or if bond beam occurs below 5-foot height, stop pour at course below bond beam.
 4. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than 1 hour. Terminate grout pours 1-1/2 inches below top course of pour.
 5. Bond Beams: Stop grout in vertical cells 1-1/2 inches below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.

3.13 FIELD QUALITY CONTROL

- A. Testing Frequency: Tests and evaluations listed in this article shall be formed during construction for each 5,000 square feet of wall area or portion thereof.
- B. Prism Test Method: For each type of wall construction indicated, masonry prisms shall be tested per ASTM E 447, Method B, and as follows:
 - 1. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.
- C. Proportion Method: Mortar shall be tested in accordance with ASTM C 780.
- D. Evaluation of Quality Control Tests: In absence of other indications of noncompliance with requirements, masonry will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

3.14 REPAIRING, POINTING, AND CLEANING:

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.
- C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain ENGINEER's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 - 4. Wet wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
 - 5. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 8-2A applicable to type of stain present on exposed surfaces.
- D. Protection: Provide final protection and maintain conditions in a manner acceptable to Installer that ensures unit masonry is without damage and deterioration at time of Substantial Completion.

END OF SECTION

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SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of structural steel Work is shown on Drawings, including Schedules, notes, and details, to show size and member location and typical connections.
- B. Products Supplied but not Installed under this Section: Anchor bolts for structural steel and anchor bolt templates.
- C. Products Installed but Not Supplied under this Section.

1.02 REFERENCES

- A. Reference Standards:
 - 1. ASTM A 6 General Requirements for Rolled Steel Plates, Shapes, and Sheet Piling, and Bars for Structural Use.
 - 2. ASTM A 27 Steel Castings, Carbon, for General Application.
 - 3. ASTM A 36 Structural Steel.
 - 4. ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 5. ASTM A 108 Steel Bars, Carbon, Cold-Finished, Standard Quality.
 - 6. ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 7. ASTM A 143 Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - 8. ASTM A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 9. ASTM A 307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 10. ASTM A 325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 11. ASTM A 384 Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
 - 12. ASTM A 385 Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
 - 13. ASTM A 490 Heat-Treated, Steel Structural Bolts, 150 ksi (1,035 MPa) Tensile Strength.
 - 14. ASTM A 500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 15. ASTM A 501 Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - 16. ASTM A 563 Carbon and Alloy Steel Nuts.
 - 17. ASTM A 588 High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4-inch (100 mm) Thick.
 - 18. ASTM A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment.
 - 19. ASTM A 759 Carbon Steel Crane Rails.
 - 20. ASTM A 780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 21. ASTM A 992 Structural Steel Shapes.
 - 22. ASTM C 1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 23. ASTM E 94 Guide for Radiographic Testing.
 - 24. ASTM E 142 Method for Controlling Quality of Radiographic Testing.
 - 25. ASTM E 164 Practice for Ultrasonic Contact Examination of Weldments.

- 26. ASTM E 165 Practice for Liquid Penetrant Examination.
- 27. ASTM E 709 Practice for Magnetic Particle Examination.
- 28. ASTM F 436 Hardened Steel Washers.
- 29. ASTM F 959 Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
- 30. AWS D1.1 Structural Welding Code - Steel.
- 31. AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination.
- 32. DOD-P-21035 Paint, High Zinc Dust Content, Galvanizing Repair.
- 33. MIL-P-26915 Primer Coating, Zinc Dust Pigmented.

1.03 DEFINITIONS

- A. Structural Steel is Work defined in American Institute of Steel Construction (AISC), "Code of Standard Practice."

1.04 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Building design is Type 2 construction according to AISC Specification for Structural Steel Buildings, Section A2.2.
 - 2. Members and Connection Design: Details shown are typical; similar details apply to similar conditions, unless otherwise shown. Verify dimensions at Site whenever possible without causing delay in Work.
 - 3. Connections:
 - a. Connections shall develop main members' full strength and shall use minimum material.
 - b. Connections to main members shall be equivalent to 2 angle AISC Standard connections in most instances. Other members shall have AISC Standard connections.
 - c. If beam reactions are not shown, each end connection, whether riveted, bolted, or welded, shall develop half total uniform load capacity ($wC/2L$), for simple beams as given in AISC Manual of Steel Construction (Ninth Edition) beam load tables, except where otherwise noted.
 - 4. Design loadings are shown on Drawings.
 - 5. Promptly notify ENGINEER if member design or connections for any area, portion, or structure, are not apparent or understood.

1.05 SUBMITTALS

- A. Shop Drawings: Submit, in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Cut details, connections, camber, holes, and other pertinent data. Denote welds by standard AWS A2.4 symbols, and show each weld's size, length, and type.
 - 2. Furnish setting drawings, templates, and directions for anchor bolt installation and anchorages installed under this Section.
 - 3. Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
 - a. Structural steel (each type): Include certified mill report copies covering chemical and physical properties.
 - b. High-strength bolts, including nuts and washers and direct tension indicators if used.

- c. Structural steel primer paint.
- d. Shrinkage-resistant grout.

B. Quality Assurance Submittals:

- 1. Test Reports: Submit tests reports for tests conducted on shop and field bolted and welded connections. Include any test data for conducted tests and test results summary.
- 2. Certificates: Submit certification that welders have satisfactorily passed AWS qualification tests.
 - a. Submit notarized compliance certificates, 1 original and 2 copies, from coating applicator that hot-dip galvanized coating meets or exceeds ASTM A 123 specified requirements or ASTM A 153 (as applicable).

C. Record Drawings: At Project closeout, submit Record Drawings of installed products, in accordance with requirements of Section 01770.

1.06 QUALITY ASSURANCE

A. Codes and Standards: Reference documents following, their commentaries, and standards referenced therein, apply to design, fabrication, and construction practices used to accomplish Work shown on Drawings. Comply with following provisions, except as otherwise shown:

- 1. AISC, "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Paragraph 4.2.1 of Standard Practice code is hereby modified by deleting following sentence: "This approval constitutes OWNER's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as part of the preparation of these Shop Drawings."
- 2. AISC "Specification for Structural Steel Buildings," including "Commentary" and Supplements thereto as issued.
- 3. AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts."
- 4. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
- 5. ASTM A 6, "General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
- 6. Research Council on Structural Connections (RCSC), "Specification for Structural Joints using ASTM A 325 Bolts."
- 7. Factory Mutual Loss Prevention Data Handbook.

B. Qualifications:

- 1. Qualifications for Welding Processes: Qualify welding processes in accordance with AWS "Standard Qualification Procedure."
- 2. Welder's Qualifications: Welding shall be done by certified welders qualified according to procedures covered in AWS D1.1., using procedures, materials, and equipment for Work.
 - a. Present evidence that welders to be employed in Work have satisfactorily passed AWS qualification tests.
 - b. If welder requires recertification, retesting is CONTRACTOR's responsibility.
- 3. Coating Applicator shall specialize in hot-dip galvanizing after fabrication and be approved by manufacturers or fabricators, or company shall follow Quality Assurance Manual of American Galvanizer's Association procedures.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading: Follow ASTM A 700, Standard Practice for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.
 - 1. Deliver anchor bolts and anchorage devices embedded in cast-in-place concrete or masonry, in ample time to not delay Work.
- B. Storage and Protection: Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Do not store materials on structure in manner that might cause distortion or damage to members or supporting structures. Repair damaged materials (or structures) or provide new materials to replace damaged materials.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Nonmetallic, Shrinkage-Resistant Grout:
 - a. "Sure-Grip Grout," Dayton-Superior.
 - b. "Master Flow," Chemrex, Inc.
 - c. "NS Grout," Euclid Chemical Co.
 - d. "Crystex," L&M Construction Chemical Co.
 - e. "Multi-Purpose," Symons.
 - f. "Five Star Grout," U.S. Grout Corp.

2.02 MATERIALS

- A. Metal Surfaces: For fabrications exposed to view, use only materials which are smooth, with surface blemish-free including pitting, rust, and scale seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning, treating, and surface finish application.
- B. Structural Steel Shapes, Plates, and Bars: ASTM A 36 or A 588 where shown on Drawings.
- C. Hot Formed Structural Steel Tubing: ASTM A 501.
- D. Cold Formed Structural Steel Tubing: ASTM A 500, Grade B.
- E. Steel Pipe: ASTM A 53, Type E or S, Grade B; or ASTM A 501.
 - 1. Finish: Black, except where shown as galvanized.
- F. Steel Castings: ASTM A 27, Grade 65-35, medium-strength carbon steel.
- G. Bridge Crane Rails: ASTM A 759.
- H. Headed Stud-Type Shear Connectors: ASTM A 108, Grade 1015 or 1020, cold finished carbon steel, with dimensions complying with AISC Specifications.

- I. Anchor Rods: Unheaded Rods: ASTM F1554.
- J. Bolt Fasteners
 - 1. Headed Bolts, Low Strength:
 - a. ASTM A 307, Grade A, carbon steel bolts and carbon steel nuts.
 - 2. Headed Bolts, High Strength Threaded Fasteners:
 - a. ASTM A 325, Type 1, heavy-hex steel structural bolts and heavy-hex carbon steel nuts, ASTM A 563.
 - b. Direct tension indicators or washers, ASTM F 959 may be used at CONTRACTOR's option.
 - 1) May use on high-strength bolted connections.
 - 2) Shall use on slip-critical connections.
 - 3. Hardened Steel Washers: ASTM F 436.
- K. Electrodes for Welding: E70XX complying with AWS Code, D1.1.
- L. Structural Steel Primer Paint: Universal rust-inhibiting primer which can accept epoxy, epoxy esters, and phenolic paints as finish coats.
- M. Non-metallic, Shrinkage-Resistant Grout: Pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water reducing agents, complying with ASTM C 1107.

2.03 FABRICATION

- A. Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate for delivery sequence which expedites erection and minimizes material handling in field.
- B. Structural steel items built into or anchored into masonry or concrete shall be completely fabricated and shall be furnished with bolts, anchors, clips, and stud anchors to engage with adjacent construction.
- C. Fabricate structural steel items in accordance with AISC Specifications and details shown on reviewed and stamped final Shop Drawings.
- D. Camber structural members to deflection shown or specified.
- E. Unless otherwise noted:
 - 1. Minimum weld size shall be 3/16 inch.
 - 2. Minimum bolt diameter shall be 3/4 inch.
 - 3. Minimum plate thickness shall be 1/4 inch.
 - 4. Minimum Connecting angle shall be 1/4-inch thick.
- F. Shop Assembly:
 - 1. Properly mark and match-mark materials for field assembly.
 - 2. Where finishing is required, complete assembly, including unit welding, before starting finishing operations.
 - 3. Shop Connections: Weld or bolt shop connections as shown.
 - 4. Install non-high-strength bolts, except where high-strength bolts are shown.

5. Bolt field connections, except where welded connections or other connections are shown.
6. High Strength Bolted Construction: Install and tighten high strength, threaded fasteners using ASTM A 325 according to RCSC Specification where high-strength bolts are shown or detailed.
7. Holes: Cut, drill, or punch holes perpendicular to metal surfaces. (Drill holes in bearing plates.) Do not flame-cut holes or enlarge holes by burning.
 - a. Holes for other Work: Provide holes for securing other Work to structural steel framing, and for passing other Work through steel framing members, as shown on Shop Drawings.
8. Welded Construction: Comply with AWS Code for procedures, appearance and weld quality, and methods used in correcting welding Work. Connections exposed after installation shall be continuously welded. Weld continuously along entire contact area except where tack welding is shown.
 - a. Assemble and weld built-up sections by methods which produce true axis alignment without warp.
9. Welded Door Frames: Build up welded doorframes attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug weld steel bar stops to frames, except where shown removable. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches o.c., unless otherwise shown.
 - a. Weld threaded nuts to framing and other specialty items to receive other Work as shown on Drawings.

2.04 FINISHES

- A. Surface Preparation: After inspection and before shipping, clean steel Work to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) procedures as follows:
 1. SSPC-SP10, "Near-White Blast Cleaning.":
 2. SSPC-SP7, "Brush Blast Cleaning."
- B. Shop Priming: Shop prime structural steel, except those members or portions listed below. Refer to painting specification 09900.
- C. Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions at rates that provide not less than 1.5 mils dry film thickness.
 1. Prime embedded steel which is partially exposed on exposed portions.
 2. Do not prime initial 2 inches of embedded areas.
 3. Do not prime surfaces which are to be welded or high strength bolted with friction-type connections.
 4. Do not prime surfaces which are scheduled to receive sprayed-on fireproofing.
 5. Apply 2 coats of paint to surfaces which are inaccessible after assembly or erection. Change second coat color to distinguish it from first.
- D. Galvanizing:
 1. Surface Preparation: Pre-clean steel Work using alkaline cleaner, acid pickle, and flux. Alternatively, blast clean and flux steel.
 2. Application of Coating: Galvanize steel members, fabrications, and assemblies after fabrication by hot-dip process in accordance with ASTM A 123.
 3. Galvanize bolts, nuts, and washers and iron and steel hardware components in accordance with ASTM A 153.
 4. Safeguard products against steel embrittlement in conformance with ASTM A 143.
 5. Handle galvanized articles in manner to avoid mechanical damage and to minimize distortion.

6. Coating Requirements: Coating Weight: Conform to Paragraph 5.1, ASTM A 123, or Table 1, ASTM A 153.
 7. Surface Finish: Continuous, adherent, as smooth and evenly distributed as possible and free from defects detrimental to coated article's stated end use.
 8. Adhesion: Withstand normal handling consistent with coating nature and thickness and normal article use.
- E. Shop Painting: Use painting methods which result in full coverage of joints, corners, edges, and exposed surfaces.
- F. Post-Galvanizing Treatments: Comply with Section 09900 for shop priming and painting.
1. Prepare galvanized metal surfaces to be field painted in accordance with paint manufacturer's recommendations.
 2. Shop-coat galvanized metal surfaces with approved primers for galvanized or other approved coatings.

2.05 SOURCE QUALITY CONTROL

- A. Tests, Inspection: Provide access for testing agency to places where structural steel Work is being fabricated or produced so that required inspection and testing can be accomplished.
1. Testing agency may inspect structural steel at plant before shipment; however, ENGINEER reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Do not proceed with erection until corrections have been made, or compensating adjustments to structural steel Work have been agreed upon with ENGINEER.
- B. Surface Preparation: Clean bearing surfaces and other surfaces which shall be in permanent contact before assembly.
1. Clean bond-reducing materials from concrete and masonry bearing surfaces and roughen to improve bond to surfaces. Clean base and bearing plates' bottom surface.
- C. Protection:
1. Provide temporary shores, guys, and bracing members with sufficiently strong connections to bear imposed loads during erection, and to keep structural steel secure, plumb, and in alignment against temporary construction loads.
 2. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment as erection proceeds.

3.02 ERECTION

- A. Setting Bases and Bearing Plates:
1. Set loose and attached base plates and bearing plates for structural members on wedges, shims, or adjusting nuts or other adjusting devices.

2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with base edge or bearing plate before packing with grout.
 3. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
 - a. For proprietary grout materials, comply with manufacturer's instructions.
- B. Site Tolerances: Establish required leveling and plumbing measurements on mean operating temperature of structure. Level and plumb individual structure members within specified AISC tolerances.
1. Set structural steel accurately in locations and to lines and elevations shown. Comply with AISC Specifications for bearing, temporary connections, alignment, and paint removal on surfaces.
 2. Splice members only where shown and accepted on Shop Drawings.
 3. Align and adjust various members forming complete frame elements or structure(s) before permanently fastening.
- C. Field Connections: Only light drifting shall be permitted to draw parts together. Drifting to match unfit holes shall not be permitted. Do not enlarge unfit holes in members by burning. Hole enlargements essential to make connections shall be done by reaming and twist drills and using proper size bolts. Do not enlarge unfit holes in members by use of drift pins except in secondary bracing members.
- D. Field Welding: Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds. On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces. Leave finish surfaces of members exposed in final structure free of markings, burrs, and other defects
- E. Field Bolting: Install and tighten non-high-strength bolts, except where high-strength bolts are shown.
- F. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting is permitted only on secondary members which are not under stress. (When authorized, finish gas-cut sections equal to sheared appearances.)

3.03 FIELD QUALITY CONTROL

- A. Engage independent testing and inspection agencies to inspect high-strength bolted connections, welded connections, to make tests and prepare test reports.
1. Testing agency shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.
 2. Provide access for testing agency to places where structural steel Work is being assembled so that required inspection and testing can be accomplished.
- B. High-Strength Field-Bolted Connections shall be tested and inspected according to RCSC's "Specification of Structural Joints Using ASTM A 325 Bolts." Direct Tension indicator gaps shall be verified to comply with ASTM F 959, Table 2.

- C. Field Welding: Inspect and test during erection of structural steel as follows:
 - 1. Certify welders and conduct inspections and tests. Record types and locations of defects found in Work. Record work required and performed to correct deficiencies.
 - 2. Perform visual inspection of all welds.
 - 3. Perform tests of welds as follows:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration not acceptable.
 - c. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 - d. Ultrasonic Inspection: ASTM E 164.
- D. Correct deficiencies in structural steel Work which inspections and laboratory test reports show as not in compliance with requirements. Carry out additional tests, at CONTRACTOR's expense, to reconfirm any original Work non-compliance and to show corrected Work compliance.

3.04 ADJUSTING

- A. Errors in shop or field Work which prevents proper assembling and parts fitting by moderate drift pin use, or moderate reaming and slight clipping, shall be corrected at CONTRACTOR's expense.

3.05 CLEANING

- A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas.
 - 1. Apply same paint to exposed areas using same material as used for final painting.
 - 2. Apply touch-up paint by brush or spray to provide 1.5 mils dry film thickness, minimum.
- B. Remove temporary shoring, members, guys, bracing, and connections when permanent members are in place and final connections made and tested.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

END OF SECTION

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SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Loose bearing and leveling plates.
 - 2. Steel lintels.
 - 3. Construction castings.
 - 4. Guard posts.
 - 5. Manual bar screen.

- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 DEFINITIONS

- A. Definitions in ASTM E 985 for railing-related terms apply to this Section.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Structural Performance: Design, engineer, fabricate, and install the following metal fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each metal fabrication.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data for products used in miscellaneous metal fabrications, including paint products and grout.
 - 2. Shop Drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 - a. Where installed metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified Professional Engineer who was responsible for their preparation.
 - 3. Samples representative of materials and finished products as may be requested by ENGINEER.
 - 4. Welder certificates signed by CONTRACTOR certifying that welders comply with requirements specified under "Quality Assurance" paragraph.
 - 5. Qualification data for firms and persons specified in "Quality Assurance" paragraph to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Engineers and Owners, and other information specified.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firms experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1, "Structural Welding Code - Steel," D1.3, "Structural Welding Code - Sheet Steel," and D1.2, "Structural Welding Code - Aluminum."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Engineer Qualifications: Professional Engineer licensed to practice in jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the successful installation of metal fabrications similar in material, design, and extent to that indicated for this Project.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Construction Castings:
 - a. James B. Clow and Sons.
 - b. McKinley Iron Works, Inc.
 - c. Neenah Foundry Company.
 - d. M.A. Industries, Inc.

2.02 FERROUS METALS

- A. For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.

1. Steel Plates, Shapes, and Bars: ASTM A 36.
 - a. For exterior installations and where indicated, provide tubing with hot-dip galvanized coating per ASTM A 53.
2. Malleable Iron Castings: ASTM A 47, Grade 32510.
3. Brackets, Flanges, and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
4. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.
5. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for the metal alloy to be welded.

2.03 FABRICATION

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on Shop Drawings using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
 1. Temperature Change (Range): 100 degrees F (55.5 degrees C).
- D. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing Work.
 1. Remove sharp or rough areas on exposed traffic surfaces.
 2. Weld corners and seams continuously to comply with AWS recommendations and the following:
 - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
 3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
 4. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

- F. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. 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.
- G. Cut, reinforce, drill, and tap miscellaneous metal Work as indicated to receive finish hardware, screws, and similar items.
- H. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.04 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

2.05 STEEL LINTELS

- A. Fabricate structural steel lintels from steel angles and shapes of size indicated or scheduled for all openings and recesses in masonry walls and partitions.
- B. Weld adjoining members together to form a single unit where indicated. Horizontal sections of lintels between the edge of the masonry opening and the end of the lintel shall be coped to allow for masonry joint not less than 1-inch deep measured from the interior and exterior faces of the masonry wall.
- C. Size lintel lengths for equal bearing of one inch per foot of clear span and not less than 4 inches bearing at each side of openings, unless otherwise indicated.
- D. See Steel Lintel Schedule on Drawings for sizes required.
- E. Galvanize all lintels after fabrication.
- F. Paint all lintels exposed to view. Paint shall be compatible with the galvanized finish.

2.06 CONSTRUCTION CASTINGS

- A. Frames and covers shall be provided of the size and type as called for on Drawings. Castings shall be set flush with the finished surface and shall be securely anchored to the structure. Where noted on Drawings, bolted gasketed frames and covers shall be provided.
- B. Manhole steps shall be provided where shown on Drawings. Steps shall be asphalt-coated cast iron or steel reinforced high-density polypropylene plastic. They shall be a minimum clear 10 inches wide and placed at 16 inches apart maximum.

Individual rung ladders shall be provided where shown on Drawings. Rungs shall be asphalt-coated cast iron or steel reinforced high-density polypropylene plastic and capable of supporting 300 pounds. They shall be a minimum clear 16 inches wide and placed at 12 inches apart maximum.

2.07 GUARD POSTS

- A. Fabricate guard posts from Schedule 80 steel pipe. Cap posts with 1/4-inch minimum thickness steel base plate. See Standard Detail on Drawings.

2.08 FINISHES

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
- B. Finish metal fabrications after assembly.

2.09 STEEL AND IRON FINISHES

- A. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process, compliance with the following requirements:
 - 1. ASTM A 153 for galvanizing iron and steel hardware.
 - 2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299-inch thick and heavier.
- B. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP6, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP3, "Power Tool Cleaning."
 - 3. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA1, "Paint Application Specification No. 1," for shop painting.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Installer Qualifications: Arrange for installation of metal fabrications specified in this Section by same firm that fabricated them.

3.02 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Site.
- B. Center nosings on tread widths with noses flush with riser faces and tread surfaces.

- C. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.03 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
 - 1. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
 - 2. 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 the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- C. Field Welding: Comply with AWS Code for procedures of manual shielded metal arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing and contour of welded surface matches those adjacent.

3.04 SETTING LOOSE PLATES

- A. Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose-leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 - 1. Use nonmetallic nonshrink grout unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.05 INSTALLATION OF GUARD POSTS

- A. Anchor posts in concrete. See standard detail on Drawings for additional information.

3.06 ADJUSTING AND CLEANING

- A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touch-up of field painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
2. For galvanized surfaces, clean welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION

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SECTION 07210 - BUILDING INSULATION

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section Includes:
 - 1. Spray polyurethane foam insulation.
 - 2. Vapor retarders.

1.02 ACTION SUBMITTALS:

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

1.03 INFORMATIONAL SUBMITTALS:

- A. Product test reports.
- B. Research/evaluation reports.

PART 2 - PRODUCTS

SPRAY POLYURETHANE FOAM INSULATION:

- A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 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. BASF Corporation.
 - b. BaySystems NorthAmerica, LLC.
 - c. Dow Chemical Company (The).
 - d. ERSystems, Inc.
 - e. Gaco Western Inc.
 - f. Henry Company.
 - g. NCFI; Division of Barnhardt Mfg. Co.
 - h. SWD Urethane Company.
 - i. Volatile Free, Inc.
 - 2. Minimum density of 1.5 lb/cu. ft. (24 kg/cu. m), thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F (43 K x m/W at 24 deg C).

2.02 VAPOR RETARDERS:

- A. Polyethylene Vapor Retarders: ASTM D 4397, 10 mils (0.25 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

PART 3 - EXECUTION

3.01 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.

3.02 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION:

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids, non-grouted cmu cores and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.03 INSTALLATION OF VAPOR RETARDERS:

- A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- C. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

END OF SECTION

SECTION 07720 - ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section Includes:
 - 1. Roof curbs.
 - 2. Equipment supports.

1.02 SUBMITTALS:

- A. Product Data: For each type of roof accessory indicated.
- B. Shop Drawings: For roof accessories.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items.
- E. Operation and maintenance data.
- F. Warranty: Sample of special warranty.

1.03 WARRANTY:

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

2.01 METAL MATERIALS:

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
 - 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 - 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.

3. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 4. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 (AZM150) coated.
1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
 2. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight
 3. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.
- C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
1. Mill Finish: As manufactured.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
 3. Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
 4. Color Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
 5. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 620; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 6. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils.
- D. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.
- E. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
- F. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

2.02 MISCELLANEOUS MATERIALS:

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).

- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWWA C2; not less than 1-1/2 inches thick.
- D. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
- E. Sealants: As recommended by roof accessory manufacturer for installation indicated.

2.03 ROOF CURBS:

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed deck-mounting flange at perimeter bottom.
 - 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. AES Industries, Inc.
 - b. Custom Solution Roof and Metal Products.
 - c. LM Curbs.
 - d. Roof Products, Inc.
 - e. Vent Products Co., Inc.
- B. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
 - 1. Finish: Two-coat fluoropolymer.
 - 2. Color: As selected by Architect from manufacturer's full range.
- C. Material: Aluminum sheet, 0.090 inch thick.
 - 1. Finish: Two-coat fluoropolymer.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Construction:
 - 1. Insulation: Factory insulated with 1-1/2-inch- thick cellulosic or glass-fiber board insulation.
 - 2. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 - 3. Factory-installed wood nailer at top of curb, continuous around curb perimeter.
 - 4. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 5. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
 - 6. Top Surface: Level around perimeter with roof slope accommodated by sloping the deck-mounting flange.
 - 7. Security Grille: Provide where indicated.
 - 8. Pipe or Tube: 1-1/4-inch ID galvanized pipe or 1-5/8-inch OD galvanized tube.
 - 9. Flat Bar: 2-inch- high by 3/8-inch- thick galvanized steel.
 - 10. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
 - 11. Pipe Ends and Tops: Covered or plugged with weather-resistant material.

12. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.
13. Fabricate joints that will be exposed to weather in a watertight manner.
14. Close exposed ends of handrail and railing members with prefabricated end fittings.
15. Fasteners: Manufacturer's standard.

3.01 INSTALLATION:

- A. General: Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
 1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing roof accessories 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. Security Grilles: Weld bar intersections and, using tamper-resistant bolts, attach the ends of bars to structural frame or primary curb walls.
- D. Seal joints with sealant as required by roof accessory manufacturer.

3.02 REPAIR AND CLEANING:

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Division 09 painting Sections. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07900 - JOINT SEALERS

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section Includes: Extent of each form and type of joint sealer as indicated on Drawings and Schedules.

Section includes joint sealers for the following locations:

- B. Section includes joint sealers for the following locations:
1. Exterior joints in vertical surfaces and nontraffic horizontal surfaces as indicated below.
 - a. Control and expansion joints in unit masonry.
 - b. Joints between different materials.
 - c. Perimeter joints between materials and frames of doors and windows.
 - d. Other joints where indicated.
 2. Exterior joints in horizontal traffic surfaces as indicated below.
 - a. Control, expansion, and isolation joints in cast-in-place concrete slabs for floors and paving.
 - b. Joints between different materials.
 - c. Other joints as indicated.
 3. Interior joints in vertical surfaces and horizontal nontraffic surfaces as indicated below.
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings.
 - c. Perimeter joints of toilet fixtures.
 - d. Other joints as indicated.
 4. Interior joints in horizontal traffic surfaces as indicated below.
 - a. Control and expansion joints in cast-in-place concrete slabs.
 - b. Other joints where indicated.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 SYSTEM PERFORMANCE:

- A. Provide joints sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

1.03 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering items included under this Section. Shop Drawing submittals shall include:
1. Product Data from manufacturer for each joint sealer product required, including instructions for joint preparation and joint sealer application.
 2. Samples for Initial Selection Purposes: Manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available for each product exposed to view.

3. Samples for verification purposes of each type and color of joint sealer required. Install joint sealer samples in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealers.
4. Certificates from manufacturers of joint sealers attesting that their products comply with specification requirements and are suitable for the use indicated.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver materials to Site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.05 PROJECT CONDITIONS:

- A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:
 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40 degrees F (4.4 degrees C).
 2. When joint substrates are wet due to rain, frost, condensation, or other causes.
- B. Joint Width Conditions: Do not proceed with installation of joint sealers where joint widths are less than allowed by joint sealer manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.06 SEQUENCING AND SCHEDULING:

- A. Sequence installation of joint sealers to occur not less than 21 or more than 30 days after completion of waterproofing, unless otherwise indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Multi-Part Nonsag Urethane Sealant for Use NT:
 - a. "Dymeric 240," Tremco, Inc.
 - b. "Dynatrol II," Pecora Corp.
 - c. "Sikaflex 2c NS", Sika Corp.
 2. One-Part Nonsag Urethane for Use NT:
 - a. "Dymonic," Tremco, Inc.
 - b. "Dynatrol I-XL," Pecora Corp.
 - c. "Sikaflex-15LM," Sika Corp.

3. One-Part Nonsag Urethane Sealant for Use T:
 - a. "Sonolastic NP 1," BASF Building Systems.
 - b. "Sikaflex-1a," Sika Corp.
 - c. "Vulkem 45 SSL," Tremco Sealant/Weatherproofing Division, RPM.
4. One-Part Pourable Urethane Sealant for Use T:
 - a. "Chem-Calk 950," Bostik Construction Products Division.
 - b. "Urexpan NR-201," Pecora Corp.
 - c. "Sikaflex-1CSL," Sika Corp.
 - d. "Vulkem 45," Tremco Sealant/Weatherproofing Division, RPM.
5. Multi-part Nonsag Immersible Polysulfide or Polyurethane Sealant:
 - a. "Synthacalk GC-2+," Pecora Corp.
 - b. "Sonolastic Polysulfide Sealant," Sonneborn, Degussa Building Systems.
 - c. "Vulkem 116," Tremco Sealant/Weatherproofing Division, RPM.
6. Pre-formed Foam Sealant:
 - a. Horizontal and Traffic Applications:
 - 1) "Emseal 20H," Emseal Corp.
 - 2) "Will-Seal EPS," Will-Seal Construction Foams Dw., Illbruck.
 - b. Vertical Applications Above Grade (Control and Expansion Joints):
 - 1) "Emseal Greyflex," Emseal Corp.
 - 2) "Polytite Standard," Sandell Manufacturing Co., Inc.
 - 3) "Will-Seal 150," Will-Seal Construction Foams Dw., Illbruck.
 - c. Below Grade Applications:
 - 1) "Emseal 20H," Emseal Corp.
 - 2) "Will-Seal 250," Will-Seal Construction Forms Dw., Illbruck.
 - d. Pre-formed Hollow Neoprene Gasket:
 - 1) The D.S. Brown Co.
 - 2) Watson-Bowman and Acme Corp.
 - 3) Williams Products, Inc.
7. Foamed-In-Place Fire-Stopping Sealant:
 - a. "Dow Corning Fire Stop Sealant," Dow Corning Corp.
 - b. "Pensil 851," General Electric Co.
8. One-Part Fire-Stopping Sealant:
 - a. "Dow Corning Fire Stop Sealant," Dow Corning Corp.
 - b. "Fyre Putty," Standard Oil Engineered Materials Co.
 - c. "Metachaulk 1100," The RectorSeal Corporation.
 - d. "RTV 7403," General Electric Co.
 - e. "3M Fire Barrier Caulk CP-25," Electrical Products Division/3M.
9. Joint Sealant Backing:
 - a. Expand-o-Foam, 1380 Series, Williams Products, Inc.
10. Joint Fillers for Concrete:
 - a. Cementone, W.R. Meadows.
 - b. Concrete Grey Sponge Rubber, 1300 Series, Williams Products, Inc.

2.02 MATERIALS, GENERAL:

- A. Compatibility: Provide joint sealers, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application as demonstrated by sealant manufacturer based on testing and field experience.

2.03 ELASTOMERIC JOINT SEALANTS:

- A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those referenced for type, grade, class, and uses.

Abbreviations

Types, Grade, Uses (Exposure)

S	Single component	Type
M	Multi-component	Type
P	Pourable	Grade
NS	Nonsag	Grade
NT	Nontraffic	Use
T	Traffic	Use
I	Immersion	Use

Uses (Joint Substrates)

A	Aluminum
O	Other
G	Glass
M	Mortar

Class

25 - Percent Movement capability

- B. Multi-Part Nonsag Urethane Sealant for Use NT: Type M, Grade NS, Class 25, and complying with the following requirements for Uses:
 - 1. Uses NT, M, A, and, as applicable to joint substrates indicated, O.
 - 2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by OWNER to match the existing Point Place Pump Station from manufacturer's standard colors.
- C. One-Part Nonsag Urethane Sealant for Use NT: Type S, Grade NS, Class 25, and Uses NT, M, A, and, as applicable to joint substrates indicated, O.
 - 1. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by OWNER to match the existing Point Place Pump Station from manufacturer's standard colors.
- D. One-Part Nonsag Urethane Sealant for Use T: Type S, Grade NS, Class 25, and complying with the following requirements for Uses:
 - 1. Uses T, NT, M, G, A, and, as applicable to joint substrates indicated, O.

2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by OWNER to match the existing Point Place Pump Station from manufacturer's standard colors.
- E. One-Part Pourable Urethane Sealant for Use T: Type S, Grade P, Class 25, and complying with the following requirements for Uses:
1. Uses T, M, A, and, as applicable to joint substrates indicated, O.
 2. Colors: Provide color of exposed joint sealers indicated, or if not otherwise indicated, as selected by OWNER to match the existing Point Place Pump Station from manufacturer's standard colors.
- F. Multi-Part Nonsag Polysulfide or Polyurethane Sealant for Uses T, NT, I: Type M, Grade NS, Class 25, and complying with the following requirements for Uses:
1. Uses T, NT, I, M, G, A, and, as applicable to joint substrates indicated, O.
 2. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by OWNER to match the existing Point Place Pump Station from manufacturer's standard colors.

2.04 COMPRESSION SEALS:

- A. Pre-formed Foam Sealant: Manufacturer's standard pre-formed, pre-compressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellent agent; factory-produced in pre-compressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed to the degree specified by manufacturer; and complying with the following requirements:
1. Properties: Permanently elastic, mildew-resistant, nonmigratory, nonstaining, compatible with joint substrates and other joint sealers.
 2. Impregnating Agent:
 - a. Chemically stabilized acrylic (EMSEAL).
 - b. Neoprene rubber suspended in chlorinated hydrocarbons (WILL-SEAL).
 - c. Polymerized polybutylene (POLYTITE).
 3. Density: 8 - 10 pounds per cubic foot.
 4. Backing: None.
- B. Pre-formed Hollow Neoprene Gasket: Manufacturer's standard pre-formed polychloroprene elastomeric joint seal of the open-cell compression type complying with ASTM D 2628 and with requirements indicated for size, profile, and cross-sectional design.

2.05 JOINT SEALANT BACKING:

- A. Provide sealant backings of material and type which are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers: Pre-formed, compressible, resilient, nonwaxing, nonextruding strips of flexible, nongassing plastic foam of material indicated below; nonabsorbent to water and gas; and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

- C. Either open-cell polyurethane foam or closed-cell polyethylene foam, unless otherwise indicated, subject to approval of sealant manufacturer, for cold-applied sealants only.
- D. Elastomeric Tubing Joint Fillers: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to -26 degrees F (-15 degrees C). Provide products with low compression set and of size and shape to provide a secondary seal, control sealant depth, and otherwise contribute to optimum sealant performance.
- E. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by 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.

2.06 MISCELLANEOUS MATERIALS:

- A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint sealer substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Provide nonstaining, chemical cleaners of type which are acceptable to manufacturer of sealants and sealant backing materials, which are not harmful to substrates and adjacent nonporous materials, do not leave oily residues, or otherwise have a detrimental effect on sealant adhesion or in-service performance.
- C. Masking Tape: Provide nonstaining, nonabsorbent type compatible with joint sealants and to surfaces adjacent to joints.

2.07 JOINT FILLERS FOR CONCRETE:

- A. Provide joint fillers of thickness and widths indicated.

Sponge Rubber Joint Filler: Pre-formed strips complying with ASTM D 1752 for Type I.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS:

- A. Installer Qualifications: Engage an installer who has successfully completed, within the last 3 years, at least 3 joint sealer applications similar in type and size to that of this Project.

3.02 EXAMINATION:

- A. Examine joints indicated to receive joint sealers, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealer performance. Do not proceed with installation of joint sealers until unsatisfactory conditions have been corrected.

3.03 PREPARATION:

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:
 - 1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealers, oil, grease, waterproofing, water repellants, water, surface dirt, and frost.
 - 2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 - 3. Remove laitance and form release agents from concrete.
 - 4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on pre-construction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.04 INSTALLATION OF JOINT SEALERS:

- A. Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated except where more stringent requirements apply.
- B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
 - 1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of joint fillers.
 - b. Do not stretch, twist, puncture, or tear joint fillers.
 - c. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material.
 - d. See Standard Detail on Drawings for face brick control joint application.
 - 2. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.

3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.
 4. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.
 - a. Note: Install all sealant in interior joints after painting of adjoining surfaces have been performed. Do not paint over sealant joints.
- D. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
1. Provide concave joint configuration per Figure 6A in ASTM C 962 unless otherwise indicated.
 2. Provide flush joint configuration per Figure 6B in ASTM C 962 where indicated.
 3. Use masking tape to protect adjacent surfaces of recessed tooled joints.
 4. Provide recessed joint configuration per Figure 6C in ASTM C 962, of recess depth and at locations indicated.
- E. Installation of Pre-formed Foam Sealants: Install each length of sealant immediately after removing protective wrappings, taking care not to pull or stretch material, and complying with sealant manufacturer's directions for installation methods, materials, and tools which produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in conformance with sealant manufacturer's recommendations.
- F. Installation of Pre-formed Hollow Neoprene Gaskets: Install gaskets, with minimum number of end joints, in joint recesses with edges free of spalls and sides straight and parallel, both within tolerances specified by gasket manufacturer. Apply manufacturer's recommended adhesive to joint substrates immediately prior to installing gaskets. For straight sections, provide gaskets in continuous lengths; where changes in direction occur, adhesively splice gaskets together to provide watertight joint. Recess gasket below adjoining joint surfaces by 1/8 to 1/4 inch.

3.05 CLEANING:

- A. Clean off excess sealants or sealant smears adjacent to joints as Work progresses, by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.06 PROTECTION:

Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original Work.

END OF SECTION

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SECTION 08110 - STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section Includes: Standard steel doors and frames as indicated on Drawings and Drawing Schedules.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturers' technical product data substantiating that products comply with requirements.
 - 2. Submit for fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.
 - 3. Provide schedule of doors and frames using same reference numbers for details and openings as those on Contract Documents.
- B. Sample warranty.

1.03 QUALITY ASSURANCE:

- A. Provide doors and frames complying with Steel Door Institute, "Recommended Specifications: Standard Steel Doors and Frames," (ANSI A250.8) and as herein specified.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver hollow metal work cartoned or crated to provide protection during transit and Site storage. Provide additional sealed plastic wrapping for factory-finished doors.
- B. Inspect hollow metal work upon delivery for damage. Minor damage may be repaired provided refinished items are equal in all respects to new work and acceptable to ENGINEER; otherwise, remove and replace damaged items as directed.
- C. Store doors and frames at building Site under cover. Place units on minimum 4-inch-high wood blocking. Avoid use of nonvented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4-inch spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Steel Doors and Frames:
 - a. Amweld; Div. American Welding & Mfg. Co.
 - b. Ceco Door Products.
 - c. Curries Mfg., Inc.
 - d. Kewanee Corp.
 - e. Mesker Industries, Inc.
 - f. Pioneer Industries; Div. CORE Industries, Inc.
 - g. Republic Builders Products Corp.; Subs. Republic Steel.
 - h. Steelcraft; Div. American Standard Co.

2.02 MATERIALS:

- A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568.
- B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.
- C. Galvanized Steel Sheets: Zinc coated carbon steel sheets of commercial quality complying with ASTM A 526, with ASTM A 525, G60 zinc coating, mill phosphatized.
- D. Supports and Anchors: Fabricate of not less than 18 gauge galvanized sheet steel.
- E. Inserts, Bolts, and Fasteners: Manufacturer's standard units, except hot-dip galvanized items to be built into exterior walls complying with ASTM A 153, Class C or D as applicable.
- F. Shop Applied Paint:
 - 1. Primer: Rust-inhibitive enamel or paint, either air drying or baking, suitable as a base for specified finish paints and which can be used on both submerged and nonsubmerged ferrous metal.

2.03 FABRICATION:

- A. Fabricate steel door and frame units to be rigid, neat in appearance, and free from defects, warp, or buckle. Wherever 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. Comply with SDI-100 requirements as follows:
 - 1. Interior Doors: ANSI A250.8, Level 2, heavy-duty, Model 2, seamless 18 gauge minimum galvanized faces.

2. Exterior Doors: ANSI A250.8, Level 3, extra heavy-duty, Model 2, seamless 16 gauge minimum galvanized faces.
- B. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled galvanized sheet steel.
 - C. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold-rolled or hot-rolled 14-gauge galvanized steel (at fabricator's option).
 - D. Fabricate exterior doors, panels, and frames from galvanized sheet steel. Close top and bottom edges of exterior doors as integral part of door construction or by addition of minimum 16-gauge inverted galvanized steel channels.
 - E. Exposed Fasteners: Unless otherwise indicated, provide galvanized countersunk flat Phillips heads for exposed screws and bolts.
 - F. Thermal-Rated (Insulating) Assemblies:
 1. At exterior and interior locations and elsewhere as shown or scheduled, provide doors which have been fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 1363.
 2. Unless otherwise indicated, provide thermal-rated assemblies with U factor of 0.24 Btu/(hour per foot square per degree F).
 - G. Finish Hardware Preparation: Prepare doors and frames to receive mortised and concealed finish hardware in accordance with final Finish Hardware Schedule and template provided by hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.
 1. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at Project Site.
 2. Locate finish hardware as indicated on final Shop Drawings or, if not shown, in accordance with "Recommended Locations for Builder's Hardware," published by Door and Hardware Institute.
 - H. Shop Painting: per Section 09900.
 1. Clean, treat, and paint exposed surfaces of steel door and frame units, including galvanized surfaces.
 2. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.
 3. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint. Primer shall be applied at the rate of 1.5 dry mils or as recommended by paint manufacturer to provide the proper base for the finish coat.

2.04 STANDARD STEEL DOORS:

- A. Provide metal doors of types and styles indicated on Drawings or Schedules.
- B. Color: As indicated on plans or, if not otherwise indicated, as selected by OWNER from manufacturers' full range of standard colors.

2.05 STANDARD STEEL FRAMES:

- A. Provide metal frames for doors, transoms, sidelights, borrowed lights, and other openings, of types and styles as shown on Drawings and Schedules. Conceal fastenings unless otherwise indicated. Fabricate frames of minimum 14-gauge galvanized cold-rolled furniture steel.
 - 1. Fabricate frames with mitered corners, welded construction, ground smooth for exterior applications and knocked-down for field assembly at new openings in existing wall applications.
 - 2. Form exterior frames of hot-dip galvanized steel.
 - 3. Color: As indicated on plans or, if not otherwise indicated, as selected by OWNER from manufacturers' full range of standard colors.
- B. Door Silencers: Except on weather-stripped frames, drill stops to receive 3 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.
- C. Plaster Guards: Provide 26-gauge steel plaster guards or mortar boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

2.06 OBSERVATION WINDOW PRESSED STEEL FRAME:

- A. Provide observation window pressed steel frames as shown on Drawings and Schedules. Frames shall be double rabbeted 14-gauge galvanized steel, depth as shown or scheduled, with 2-inch jamb and sill widths. Head section shall be heights as shown or required. Frames shall be arc-welded and ground smooth. Provide glass stops and appropriate anchors for securely holding frames in walls.
 - 1. See Standard Details on Drawings, Gas Tight Observation Window for Masonry Wall.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install standard steel doors, frames, and accessories in accordance with final Shop Drawings, manufacturer's data, and as specified in this Section.
- B. Placing Frames: Comply with provisions of SDI-105, "Recommended Erection Instructions for Steel Frames," unless otherwise indicated.
 - 1. Except for frames located in concrete or existing masonry and at drywall installations, place frames prior to construction at enclosing walls and ceilings. 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.
 - 2. In masonry construction, locate 3 wall anchors per jamb at hinge and strike levels.
 - 3. At in-place concrete or existing masonry construction, set frames and secure to adjacent construction with machine screws and masonry anchorage devices.
- C. Door Installation:
 - 1. Fit hollow metal doors accurately in frames, within clearances specified in SDI-100.

3.02 ADJUST AND CLEAN:

- A. Prime Coat Touch-up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Protection Removal: Immediately prior to final inspection, remove protective plastic wrappings from pre-finished doors.
- C. Final Adjustments: Check and readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

END OF SECTION

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SECTION 08520 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Aluminum window units, including each type, grade, and performance class required, as indicated on Drawings and Schedules.
- B. Types of aluminum window units required include:
 - 1. Fixed windows.
- C. Applications of aluminum windows on Project include:
 - 1. Individual units set in conventional wall construction.
- D. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 DEFINITIONS

- A. Performance class number included as a part of the window designation system is the actual design pressure in pounds per square feet used to determine the structural test pressure and water test pressure.
- B. Structural test pressure, windload test, is equivalent to 150 percent of the design pressure.
- C. Water leakage resistance test pressure is equivalent to 15 percent of the design pressure with 2.86 pounds per square foot as a minimum.

1.03 SYSTEM DESCRIPTION

- A. Aluminum window units required include:
 - 1. Heavy commercial grade of the performance class indicated.
- B. Design Requirements: Comply with air infiltration, water penetration, and structural performance requirements indicated in AAMA 101 for the type, grade, and performance class of window units required.
 - 1. Heights of window units above grade at the window centerline are indicated or can be determined from Drawings. Consult with ENGINEER for clarification needed to confirm required loading and test pressures.
 - 2. Design wind velocity at the Site is 140 miles per hour.
- C. Testing: Test each type and size of required window unit through a recognized testing laboratory or agency, in accordance with ASTM E 330 for structural performance, with

ASTM E 283 for air infiltration, and with both ASTM E 331 and ASTM E 547 for water penetration. Provide certified test results.

- D. Structural Performance: Provide units with no failure or permanent deflection for a positive (inward) and negative (outward) test pressure of 75 pounds-force per square foot.
- E. Air Infiltration: Provide units with an air infiltration rate of not more than 0.37 cfm per foot of operable sash joint for an inward test pressure of 6.24 pounds-force per square foot.
- F. Water Penetration: Provide units with no water penetration as defined in the test method at an inward test pressure of 3.00 pounds-force per square foot.
- G. Condensation Resistance: Where window units are indicated to be of thermal-break construction, provide units which have been tested for thermal performance in accordance with AAMA 1502 showing at condensation resistance factor (CRF) of 45.
- H. Sound Insulation Construction: Fabricate aluminum window units that have been certified to provide a sound transmission class (STC) rating of at least 40 when tested in accordance with ASTM E 90 and classified according to ASTM E 413.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Drawings for each type of window, including information not fully detailed in the manufacturer's standard product data and the following:
 - a. Typical unit elevations at 3/4-inch scale.
 - b. Anchors.
 - c. Hardware.
 - d. Accessories.
 - e. Glazing details.
 - 2. Product Data: Submit manufacturer's product specifications, technical product data, recommendations and standard details for each type of aluminum window unit required. Include the following information:
 - a. Fabrication methods.
 - b. Finishing.
 - c. Hardware.
 - d. Accessories.
- B. Test Report: Provide certification by the manufacturer showing that each type, grade, and size of window unit complies with requirements where the manufacturer's standard window units have been tested in accordance with specified tests and meet performance requirements specified. Where such testing has not been accomplished, perform required tests through a recognized testing laboratory or agency and provide certified test results.

- C. Warranty: Submit in accordance with requirements of Section 01740, Warranties covering the items included under this Section.

1.05 QUALITY ASSURANCE

- A. Standards: Requirements for aluminum windows, terminology and standards of performance, and fabrication workmanship are those specified and recommended in AAMA 101 and applicable general recommendation published by AAMA and AA.
- B. Single Source Responsibility: Provide aluminum windows produced by a single manufacturer capable of showing prior production of units similar to those required for the Project.
- C. Design Criteria:
 - 1. Drawings are based on a specific type and model of aluminum window by a single manufacturer. An equivalent type of window by another listed manufacturer may be accepted provided that deviations in dimensions and profiles are minor and do not materially detract from the design concept or intended performances as judged solely by ENGINEER.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Where possible, check actual window openings in construction work by accurate field measurement before fabrication; show recorded measurements on final Shop Drawings. Coordinate Fabrication Schedule with construction progress as directed by CONTRACTOR to avoid delay of Work. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit of window units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Fixed Windows:
 - a. Custom Window Company.
 - b. Desco Windows.
 - c. Graham Architectural Products Corporation.
 - d. Kawneer Company, Inc.
 - e. Modu-Line Windows, Inc.
 - f. Peerless Products, Inc.
 - g. TRACO.
 - h. Wausau Window and Wall Systems.

2.02 MATERIALS

- A. Aluminum Extrusions: Provide alloy and temper recommended by the window manufacturer for the strength, corrosion resistance, and application of required finish, but not less than 22,000 psi ultimate tensile strength, and not less than 0.062-inch thickness at any location for main frame and sash members.
- B. Fasteners: Provide aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by the manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components of window units.
 - 1. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125-inch thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard noncorrosive pressed-in splined grommet nuts.
 - 2. Exposed Fasteners: Except where unavoidable for application of hardware, do not use exposed fasteners. For application of hardware, use fasteners that match the finish of the member or hardware being fastened, as appropriate.
- C. Anchors, Clips, and Window Accessories: Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel or iron complying with the requirements of ASTM A 386. Provide sufficient strength to withstand design pressure indicated.
- D. Compression Type Glazing Strips and Weather Stripping: Unless otherwise indicated, and at manufacturer's option, provide compressible stripping for glazing and weather stripping such as molded EPDM or neoprene gaskets complying with AAMA SG-1 or with ASTM D 2000, Designation 2BC415 to 3BC620, or molded PVC gaskets complying with ASTM D 2287, or molded expanded EPDM or neoprene gaskets complying with ASTM C 509, Grade 4.
- E. Sealant: For sealants required within fabricated window units, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating. Comply with Section 07900, Joint Sealers for selection and installation of sealants.

2.03 WINDOW GRADES AND PERFORMANCE CLASSIFICATION

- A. Heavy Commercial Windows: Provide window units complying with requirements of AAMA Grade and Performance Class HC40.

2.04 WINDOW TYPES

- A. The following paragraphs define the operating arrangement for the types of sash required in window units and specify minimum provisions for each type. Drawings indicate which panels of each window unit are operable sash and which are fixed.

2.05 HARDWARE

- A. Except to the extent that more specific or stringent requirements are indicated, provide the manufacturer's standard hardware fabricated from aluminum, stainless steel, or other corrosion-resistant material compatible with aluminum and of sufficient strength to perform the function for which it is intended.
 - 1. Four-bar friction hinges for casement windows shall comply with the requirements of AAMA 904.1.
 - 2. Friction Shoes: Provide friction shoes of nylon or other non-abrasive, non-staining, non-corrosive, durable material.
 - 3. Counterbalancing mechanism for single-, double-, or triple-hung windows shall comply with the requirements of AAMA 902.2.
 - 4. Gear-type rotary operators for awning, casement, and jalousie windows shall comply with the requirements of ASTM E 405, Method A, when subjected to the operating moments and closing torques indicated in AAMA 101.
- B. Window Types:
 - 1. Fixed windows are inoperable units. Except for special provisions as indicated for maintenance, cleaning and removal, no operating hardware or equipment is required.

2.06 ACCESSORIES

- A. Except to the extent that more specific or stringent requirements are indicated, provide manufacturer's standard accessories that comply with indicated standards.

2.07 FABRICATION

- A. Except to the extent that more specific or stringent requirements are indicated, provide manufacturer's standard fabrication that complies with indicated standards and that produces units that are reglazable without dismantling sash framing. Include a complete system for assembly of components and anchorage of window units, and prepare sash for glazing except where pre-glazing at the factory is indicated.
- B. Sizes and Profiles: Required sizes for window units and profile requirements are indicated on Drawings. Variable dimensions are indicated along with maximum and minimum dimensions as required to achieve design requirements and coordination with other Work.
 - 1. Details shown are based upon standard details by one or more manufacturers. Similar details by other manufacturers will be acceptable, provided they comply with size requirements, minimum/maximum profile requirements, and performance standards as indicated or specified.
- C. Thermal Break Connection: Fabricate aluminum window units with an integrally concealed low conductance thermal barrier, located between exterior materials and window members exposed on the interior, in a manner that eliminates direct metal-to-metal contact. Provide thermal break construction which has been in use for not less than 3 years, has been tested to

demonstrate resistance to thermal conductance and condensation, and has been tested to show adequate strength and security of glass retention.

1. Pre-glazing Fabrication: Pre-glaze window units at the factory where possible and practical for applications indicated. Comply with glass and glazing requirements of Section 08800, Glass and Glazing and AAMA 101.

2.08 FINISHES

- A. Organic Coating: Provide shop applied organic coating of the type and color indicated or selected by OWNER, tested and certified by the window manufacturer to comply with AAMA 603.6.
 1. Provide the manufacturer's electrolytically applied, baked-on acrylic or polyester enamel coating of 1.5 mils dry film thickness. Apply coating over manufacturer's standard substrate preparation including chromate conversion coating.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect openings before beginning installation. Verify that rough or masonry opening is correct and the sill plate is level.
 1. Masonry surfaces shall be visibly dry and free of excess mortar, sand, and other construction debris.
 2. Metal surfaces shall be dry, clean, free of grease, oil, dirt, rust and corrosion, and welding slag, without sharp edges or offsets at joints.

3.02 INSTALLATION

- A. Comply with manufacturer's specifications and recommendations for installation of window units, hardware, operators, and other components of the Work.
- B. Set units plumb, level and true to line, without warp or rack of frames or sash. Provide proper support and anchor securely in place.
 1. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with the requirements specified under paragraph "Dissimilar Materials" in the Appendix to AAMA 101.
- C. Set sill members and other members in a bed of compound or with joint fillers or gaskets, as shown, to provide weathertight construction. Refer to Section 07900, Joint Sealers for compounds, fillers, and gaskets to be installed concurrently with window units. Coordinate installation with wall flashings and other components of the Work.

3.03 ADJUSTING

- A. Adjust operating sash and hardware to provide a tight fit at contact points and at weather stripping for smooth operation and a weathertight closure.

3.04 CLEANING

- A. Clean aluminum surfaces promptly after installation of windows. Exercise care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt, and other substances. Lubricate hardware and other moving parts.

END OF SECTION

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SECTION 08710 - FINISH HARDWARE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.
- B. It is the intent of this Project to match the hardware at the OWNER'S Water Treatment Plant. CONTRACTOR is responsible for familiarizing himself with the hardware of the Water Treatment Plant, either during the Bid Phase or as part of the Shop Drawing preparation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 08110 – Hollow Metal Doors and Frames

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:
 - 1. ANSI/BHMA 156

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
 - 1. Manufacturers data for each item of hardware. Include installation and maintenance instructions.
 - 2. Furnish templates to fabricators of other work which is to receive hardware.
 - 3. Hardware schedule organized into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other work (such as hollow metal frames) which may be critical in the project construction schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with shop drawings for other work, delivery schedules and similar information has been completed and accepted.

1.05 QUALITY ASSURANCE

- A. Provide materials, assemblies, equipment and services from a single source for each category except that locksets, latchsets and cylinders must originate from the same manufacturer.
- B. Replace any item of finish hardware which cannot be installed or will not function properly.
- C. Provide hardware complying with NFPA 80 and UL labeled for fire rated openings.
- D. Furnish templates or information to door and frame manufacturer. Coordinate between the manufacturers where two or more articles of hardware are to be mounted on the same door. Verify all dimensions, new and existing.

- E. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Handle, store, distribute, protect and install hardware in accordance with manufacturer's instructions or recommendations. Deliver packaged materials in original containers with seals unbroken and labels intact.
- B. Properly mark or label, so each piece of hardware is readily identifiable with the approved hardware schedule. Tag each change key or otherwise identifying the door of which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and hardware schedule.
- C. Provide secure storage area for hardware.

PART 2 – PRODUCTS

2.01 MATERIALS AND FABRICATION

- A. Hand of Door
 - 1. Drawings show swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish hardware for proper installation and operation of door.
- B. Manufacturer's Name Plate
 - 1. Do not use manufacturer's products which have name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels.
- C. Base Metals
 - 1. Produce hardware units of the basic metal and forming method indicated, using manufacturer's non-corrosive metal alloy, composition, temper and hardness but in no case of lesser quality material than specified.
- D. Fasteners
 - 1. Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
 - 2. Furnish stainless steel fasteners for installation with each hardware item. Exposed finish (under any condition) to match hardware finish or surfaces of adjacent work. Match the finish of adjacent work as closely as possible, including surfaces to receive painted finish.
 - 3. Provide fasteners which are compatible with unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.
- E. Tools for Maintenance
 - 1. Furnish a complete set of specialized tools as needed for Owner's continued adjustment, maintenance, removal and replacement of builders hardware.

F. Hardware Finishes

1. Stainless steel, US32D unless otherwise noted.
2. Closers shall have a USP finish unless otherwise noted.

G. Field Checks

1. Make periodic checks during installation of finish hardware to ascertain the correctness of the installation. After completion of the work, certify in writing, that all items of finish hardware have been installed, adjusted and are functioning in accordance with Specification requirements.

2.02 DESCRIPTION OF PRODUCTS

A. Hinges

1. Stainless steel full mortise concealed oil impregnated ball bearing type, five knuckle with non-rising pins for interior doors, and non-removable and non-rising pins for exterior doors. Tips shall be flat.
2. Sizes and weights of hinges:
 - a. Doors up to 40 inches - 5 inches regular weight.
 - b. Doors 40 inches to 48 inches - 5 inches heavy weight.
3. Provide three hinges per door leaf up to and including 90 inches and one additional hinge for each 30 inches of additional height.
4. Acceptable Manufacturers: Stanley Hardware, Hager Hardware

B. Locksets and Latchsets

1. Stainless steel, heavy-duty mortise type conforming to ANSI A156.13 Series 1000, Grade 1.
2. Wrought steel box strikes.
3. Stainless steel deadbolt with 1" throw approval.
4. 2 3/4 inch back set, 3/4 inch throw, two-piece anti-friction latchbolt.
5. Non-ferrous critical internal parts.
6. Cylinders shall be manufactured to conform to grand master key program.
7. Trim design shall match existing. Provide lever design throughout.
8. Acceptable Manufacturers: Best Access Systems. This is the site standard, and no substitutions will be allowed.

C. Keys and Keying

1. Provide construction keyed, removable core master key system as directed by the Owner. Owner shall remove construction core.
2. Acceptable Manufacturers: Best Access System. This is the site standard, and no substitutions will be allowed.

D. Panic Hardware

1. Panic hardware shall be provided for the exit on all doors.
2. Heavy duty push bar exit device, U.L. labeled, with corrosive resistant construction aluminum clear anodized.
3. ANSI A156.3, Grade 1.
4. Exterior trim to closely match locksets.
5. Single/active doors: mortise type.
6. Double doors: concealed vericle rod.
7. ANSI Function 08.

- E. Closers
 - 1. Cast iron case with seamless one-piece forged steel spring tub.
 - 2. Heavy duty forged steel arm.
 - 3. Non-sized fully adjustable from size 1-6.
 - 4. Backcheck intensity and location valves.
 - 5. Delayed action closing.
 - 6. Full metal cover.
 - 7. Mechanical hold open device, except at fire rated doors.
 - 8. ANSI 156.4, Grade 1.
 - 9. Conforms to ADA 5 lbf. maximum door opening force requirement for non-fire rated interior doors.
 - 10. Provide mounting brackets, and fasteners required for proper attachment.
 - 11. Acceptable manufacturers: Corbin/Russwin, LCN, Norton

- F. Door Stops and Bumpers
 - 1. Provide door stops and/or bumpers for all doors that come in contact with the surrounding walls upon opening.
 - 2. Finish: Satin chrome plated.
 - 3. Floor mounted door stops.
 - a. Acceptable manufacturers and products: H.B. Ives 444, Hager Hardware Model 267F, and Glynn-Johnson Model FB36.
 - 4. Wall bumpers
 - a. Acceptable manufacturers and products: H.B. Ives Model 407, Hager Hardware Model 234W, and Glynn-Johnson Model 60C.

- H Flush Bolts
 - 1. U.L. listed.
 - 2. Forged brass construction, 1/2" diameter flattened bolt tip, 12" long rod.
 - 3. Fit standard ANSI door preparation.
 - 4. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

- I. Kickplates
 - 1. Provide kick plates on all doors.
 - 2. Stainless steel, 0.050" thick, beveled 3 sides, 8" high, width 2 inches less than door width.
 - 3. Acceptable manufacturers: H.B. Ives, Hager Hardware, and Builders Brass Works.

- J. Silencers
 - 1. Rubber silencers: 3 for each single door and 2 for each double doors.
 - 2. Acceptable manufacturers and products: Glynn-Johnson Models 64 or 65, Hager Hardware Models 308D or 307D, H.B. Ives Models 20 or 21.

- K. Thresholds
 - 1. Extruded aluminum saddle type with stainless steel fasteners. Six inches wide or as shown on drawings.
 - 2. Acceptable manufacturers: Pemko, National Guard Products, Incorporated, and Zero International.

- L. Door Bottom Seal
 - 1. Extruded aluminum with neoprene seal.

2. Acceptable manufacturers and products: Pemko Model 57, Zero International Model 328 and National Guard Products, Inc. Model 96.

M. Weatherstripping

1. Extruded aluminum with neoprene seal.
2. U.L. Labeled.
3. Acceptable manufacturers and products: Pemko Model 294, National Guard Products, Inc. Model 190, and Zero International Model 328.

N. Automatic Flush Bolts

1. U.L. listed.
2. Forged brass or stainless steel construction, ½” diameter flattened bolt tip, 12” long rod.
3. Fully automatic.
4. Operation shall incorporate an override function.
5. Tested for a minimum of 100,000 cycles.
6. Provide dust proof strikes.
7. Acceptable Manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

O. Coordinator

1. U.L. labeled and tested for 100,000 cycles.
2. Stop mounted, provide filler strips to fully cover stop.
3. Adjustable holding power and override feature.
4. Acceptable Manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

PART 3 – EXECUTION

3.01 GENERAL

A. Templates

1. After the hardware schedule is approved furnish to the various manufacturers, required blueprint templates for fabrication purposes. Templates shall be made available not more than ten (10) days after receipt of the approved hardware schedule.

B. Packaging and Marking

1. Ship hardware with proper non-corrosive fastenings for secure application. Each package of hardware shall be legibly marked indicating the part of the work for which it is intended. Markings shall correspond with the item numbers shown on the approved hardware schedule. Keys shall be tagged within each package set and plainly marked on the face of the envelope with the key control number, door designation and all identification as necessary.

3.02 INSTALLATION

A. Install hardware in a manner which will eliminate cracks on surfaces.

B. Mount hardware units at heights recommended in "Recommended Locations for Builders Hardware" by BHMA, in accordance the Americans with Disabilities Act (ADA), except as otherwise indicated or required to comply with governing regulations.

- C. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on the substrate.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as is necessary for proper installation and operation.
- E. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with factory standards.
- F. Cut and fit thresholds and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.
- G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.
- H. Set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture. Do not plug drainage holes or block weeps. Remove excess sealant.

3.03 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function. Lubricate moving parts as recommended by manufacturer. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application.
- B. Final Adjustment
 - 1. One week prior to acceptance or occupancy make a final check and adjustment of all hardware items. Clean and relubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices and compensate for final operation of heating and ventilating equipment.
- C. Instruct Owner personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.04 HARDWARE SETS

- A. The door hardware sets on the Drawings indicates functional and general requirements. Items shall be quality and finish as specified. Hardware set identification refers to set numbers indicated on the Drawings. Consult Drawings for set number required.

B. Hardware shall be as follows:

Hardware Sets

Double Door Exterior

1. Hinges
 - Panic Hardware
 - Door Closer (each leaf)
 - Coordinator
 - Automatic Flush Bolts
 - Kickplate
 - Weatherstripping
 - Threshold
 - Door Bottom Seal
 - Astragal w/Weatherstripping
 - Silencers
- Note: Accessories as required for each leaf

Exterior Single Door

2. Hinges
 - Lockset
 - Automatic Flush Bolts
 - Kick Plate
 - Weatherstripping
 - Door Bottom Seal
 - Floor Stop
 - Panic Hardware
 - Door Closer
 - Threshold
 - Silencers

Interior Door

3. Hinges
 - Panic Hardware
 - Door Closer
 - Automatic Flush Bolts
 - Kick Plate
 - Silencers
 - Door Bottom Seal
 - Floor Stop

END OF SECTION

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SECTION 08800 - GLASS AND GLAZING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Glass and glazing work as indicated on Drawings and Schedules. Types of Work in this Section include glass and glazing for:
 - 1. Window units not indicated as pre-glazed.

1.02 SYSTEM DESCRIPTION

- A. Provide glass and glazing that has been produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable) without failure. Includes loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glass and glazing materials, and other defects in Work.
 - 1. Deterioration of insulating glass is defined as failure of hermetic seal due to causes other than breakage which results in intrusion of dirt or moisture, internal condensation or fogging, deterioration of protected internal glass coating, if any, resulting from seal failure, and any other visual evidence of seal failure or performance.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Manufacturer's technical data for each glazing material and fabrication glass product required, including installation and maintenance instructions.
 - 2. Samples: For verification purposes, 12-inch square samples of each type of glass indicated, and 12-inch-long samples of each color required for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative of adjoining framing system in color.
- B. Quality Assurance Submittals: Submit certificates from respective manufacturers attesting that glass and glazing materials provided for Project comply with requirements.
 - 1. Separate certification will not be required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authorities having jurisdiction.
- C. Compatibility and Adhesion Test Report: Submit statement from sealant manufacturer indicating that glass and glazing materials have been tested for compatibility and adhesion with glazing sealants and interpreting test results relative to material performance, including recommendations for primers and substrate preparation needed to obtain adhesion.

1.04 QUALITY ASSURANCE

- A. Glazing Standards: Comply with recommendations of Flat Glass Marketing Association (FMGA), Glazing Manual and Sealant Manual, except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this Section or other referenced standards.
- B. Safety Glazing Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.
- C. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers or at least one component pane of units with appropriate certification label of inspecting and testing organization indicated below:
 - 1. Insulating Glass Certification Council (IGCC).
- D. Single Source Responsibility: To ensure consistent quality of appearance and performance, provide materials produced by a single manufacturer or fabricator for each kind and condition of glass indicated and composed of primary glass obtained from a single source for each type and class required.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect glass and glazing materials during delivery, storage, and handling to comply with manufacturer's directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture including condensation, of temperature changes, of direct exposure to sun, and from other causes.

1.06 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing material manufacturer or when joint substrates are wet due to rain, frost, condensation or other causes.

1.07 WARRANTY

- A. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

Warranty Period: **10** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Manufacturers of Insulating Glass:
 - a. AFG Industries, Inc.
 - b. Guardian Industries Corp.
 - c. PPG Industries, Inc.

2.02 GLASS PRODUCTS, GENERAL

- A. Primary Glass Standard: Provide primary glass which complies with ASTM C 1036 requirements, including those indicated by reference to type, class, quality and, if applicable, form, finish, mesh, and pattern.
 - 1. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

2.03 PRIMARY GLASS PRODUCTS

- A. Clear Float Glass: Type I, (transparent glass, flat), Class 1, Quality q3 (glazing select).

2.04 SEALED INSULATING GLASS UNITS:

- A. Provide pre-assembled units consisting of organically sealed panes of glass enclosing a hermetically sealed dehydrated air space and complying with ASTM E 774 for performance classification indicated, as well as with other requirements specified for glass characteristics, air space, sealing system, sealant, spacer material, corner design, and desiccant.
 - 1. For properties of individual glass panes making up units, refer to product requirements specified elsewhere in this Section applicable to types, classes, kinds, and conditions of glass products indicated.
 - 2. Performance Classification per ASTM E 774, Class A.
 - 3. Thickness of each Pane:
 - a. 1/4 inch.
 - 4. Air Space Thickness:
 - 5. 1/2-inch. Sealing System:
 - a. Manufacturer's standard.
 - 6. Spacer Material:
 - a. Manufacturer's standard metal.
 - 7. Corner Construction: Manufacturer's standard corner construction.
- B. Uncoated Insulating Glass Units: Manufacturer's standard units complying with the following requirements:
 - 1. Exterior Pane:
 - a. Clear float glass.
 - 2. Kind:
 - a. Tempered.
 - 3. Interior Pane of Glass: Clear float glass.

2.05 GLAZING GASKETS

- A. Lock-Strip Gaskets: Neoprene extrusions of size and shape indicated, fabricated into frames with molded corner units and zipper lock strips, complying with ASTM C 542; black.
 - 1. Neoprene, ASTM 864.

2.06 MISCELLANEOUS GLAZING MATERIALS

- A. Compatibility: Provide products of material, size, and shape with referenced glazing standard, requirements of manufacturers of glass, and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric material with a Shore Type A durometer hardness recommended by glass manufacturer to maintain glass lites in place for application indicated.
- E. Edge Blocks: Elastomeric material of hardness required to limit lateral movement (side-walking).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Require Glazier to inspect Work of glass framing erector for compliance with manufacturing and installation tolerances, including those for size, squareness, offsets at corners; for presence and functioning of weep system; for existence of minimum required face or edge clearances; and for effective sealing of joinery. Obtain Glazier's written report listing conditions detrimental to performance of glazing work. Do not allow glazing work to proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean glazing channels and other framing members to receive glass immediately before glazing. Remove coatings which are not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

3.03 GLAZING

- A. Comply with combined printed recommendations of glass manufacturers, of manufacturers of sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those of referenced glazing standards.

- B. Glazing channel dimensions as indicated in details are intended to provide for necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by job conditions at time of installation.
- C. Protect glass from edge damage during handling and installation; use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass with flares or bevels along one horizontal edge which would occur in vicinity of setting blocks so that these are located at top of opening. Remove from Site and dispose of glass units with edge damage or other imperfections of kind that, when installed, weakens glass and impairs performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by pre-construction sealant-substrate testing.
- E. Install setting blocks of proper size in sill rabbet, located one-quarter of glass width from each corner, but with edge nearest corner not closer than 6 inches from corner unless otherwise required. Set blocks in thin course of sealant which is acceptable for heel bead use.
- F. Provide spacers inside and out of correct size and spacing to preserve required face clearances, for glass sizes larger than 50 united inches (length plus height), except where gaskets or glazing tapes with continuous spacer rods are used for glazing. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width, except with sealant tape use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking to comply with requirements of referenced glazing standard, except where otherwise required by glass unit manufacturer.
- H. Set units of glass in each series with uniformity of pattern, draw, bow, and similar characteristics.
- I. Provide compressible filler rods or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glass channel weep systems and from adhering to joints back surface as well as to control depth of sealant for optimum performance, unless otherwise indicated.
- J. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- K. Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized tapes and gaskets to protrude slightly out of channel, so as to eliminate dirt and moisture pockets.
- L. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage to ensure that gasket will not walk out when installation is subjected to movement.
- M. Miter-cut wedge-shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent pull away at corners; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.04 PROTECTION AND CLEANING

- A. Protect exterior glass from breakage immediately upon installation by use of crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove immediately by method 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 often than once a month, for build-up of dirt, scum, alkali deposits, or staining. When examination reveals presence of these forms of residue, remove by method recommended by glass manufacturer. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged in other ways during construction period, including natural causes, accidents and vandalism.
- D. Wash glass on both faces not more than four days prior to date scheduled for inspections intended to establish date of Substantial Completion in each area of Work. Wash glass by method recommended by glass manufacturer.

3.05 GLASS SCHEDULE

- A. Refer to drawings for size and location.

END OF SECTION

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. It is the intent of this Section that all painting necessary to result in a complete, finished appearing facility be accomplished. As part of the work of this Section, prepare surfaces that are to be painted and furnish and apply paint materials. Paint schedules follow the text of this Section and define the surface preparation and coating systems required to paint the various types of surfaces that are to be painted. The Paint Application Table below identifies the areas to receive the paint systems specified in the paint schedules. For items or areas not listed in the Paint Application Table, consult the ENGINEER for the proper system to be used. Exclusion from the Paint Application table does not necessarily indicate that an item or area does not require painting.
- B. Acceptable manufacturers shall be Tnemec and Carboline.
1. The paint schedules that follow this specification have been developed for Tnemec products. If Carboline products are to be used, submit schedules describing Carboline's equal products and colors for review and approval.
- C. Paint Application Table

Schedule C2: Interior Concrete

Paint all interior concrete building walls, ceilings, columns bases and equipment/housekeeping pads and other related work that are exposed to view within the new station and boiler room/corridor.

Painting work under Schedule C2 is not required on concrete building ceilings and walls that are not exposed to view in the final work or on concrete floors.

Choice of color required. Number of colors: Three (max.) per room.

Schedule C5: Interior Masonry

Paint all interior masonry building walls and other related work that are exposed to view within the new station.

Walls to be painted prior to installation of conduit and equipment.

Painting work under Schedule C5 is not required on masonry walls that are not exposed to view in the final work.

Choice of color required. Number of colors: Three (max.) per room.

Schedule C7: Interior Concrete Floors

Paint all exposed interior concrete floors within the new pump stations.

Painting of floors shall not be performed until all significant construction activities have been completed.

Choice of color required. Number of colors: One per room.

Deductive alternate for interior concrete floors:

Water based Concrete Floor Sealer System MPI INT 3.2G in lieu of water borne acrylic epoxy.

1. First Coat: Sealer, water based, for concrete floors, matching topcoat.
2. Topcoat: Sealer, water based, for concrete floors, MPI #99.

Schedule M1: Exterior Metal

Paint steel lintels, exterior surfaces of hollow metal doors and frames, louvers and dampers in exterior walls, guard rails, fence, steel grating, steel stair treads, all metal exterior mechanical and electrical equipment except equipment with a baked on factory finish, and all related work.

Painting work under Schedule M1 is not required on prefinished metal siding, aluminum doors and windows, exterior signage, aluminum flagpole or prefinished metal roofing. Pretreatment (Schedule M7) followed by touch-up painting of damaged galvanizing on galvanized metal items with a zinc-rich primer shall be performed before application of paint.

Choice of colors required. Multiple colors may be required for certain items. Number of colors: Six (max).

Schedule M2: Interior Metal

Paint the following interior metal items: metal decking, monorails, structural steel framing, steel joists, metal roof decking, steel lintels, hollow metal doors and frames, hollow metal window frames, process piping, pumps (including discharge heads), motor stands, equipment base plates, steel and copper piping and plumbing, piping and plumbing hangers and supports, exposed-to-view metallic electrical conduits and wiring device enclosures, gas piping, all mechanical and electrical equipment except equipment with a baked-on factory finish, and all related work.

Painting work under Schedule M2 is not required on light gage metal stud wall framing, aluminum checkered plate, aluminum-framed metal doors and windows, fire extinguishers, or galvanized steel ductwork. Pretreatment (Schedule M7) followed by touch-up painting of damaged galvanizing on galvanized metal items with a zinc-rich primer shall be performed before application of paint.

Painting of piping shall not occur with water moving through the piping. Painting of all piping must be approved by the ENGINEER before the piping is insulated. Any piping covered by a support or hanger shall be painted before placement on the support or in the hanger, no unpainted sections of pipe shall be allowed.

Choice of colors required. Multiple colors will be required for different items. Number of colors: Twelve (max).

Schedule M7: Pretreatment of Galvanized and Nonferrous Metals

Pretreating is required on copper and galvanized pipe, aluminum items that will be painted under schedules M1 and M2, items in contact with concrete or dissimilar metals, and on damaged galvanizing of galvanized metal items prior to touch-up painting. Pretreating is not required on galvanized steel, aluminum or other nonferrous materials for items that do not require touch-up painting or are not specified to be painted.

Schedule P1: Interior Plastics

Paint plastic piping, plumbing and conduit and all related work.

Painting work of this Section is not required for room identification signs or equipment identification tags.

Choice of color required. Multiple colors will be required for different items. Number of colors: Six (max).

Schedule PP1: Process Piping

Paint carbon steel and ductile iron piping, plumbing, vents, insulation, condensate drains, gas lines and all related work.

Choice of color required. Number of colors: Up to six.

- D. In addition to the painting indicated in the above Paint Application Table, paint all aluminum surfaces that will be in contact with concrete or dissimilar metals using two coats of the prime coat specified for Exterior Metal. Coordinate painting with the fabrication of components and with the work of other trades so as to ensure the full and correct application of paint materials.
- E. In addition to the painting indicated in the above Paint Application Table, apply touch-up paint to finish defects and field cuts, welds, and penetrations of galvanized metal. Prepare and pretreat surfaces in accordance with Schedule M7 above and finish paint according to the appropriate paint schedule.
- F. Prime and finish painting, regardless of the location in which the work is performed, shall conform to all requirements of this Section. Coordinate painting with the fabrication of components and with the work of other trades so as to ensure the full and correct application of paint materials.

1.02 DEFINITIONS

- A. For the purposes of this Section, the following definitions apply: "Exposed to View" means all surfaces in the final work that could be seen from any vantage point from any height. "Paint" means all pretreatment, prime, intermediate and final coatings specified herein including clear, translucent and opaque materials.

1.03 QUALITY ASSURANCE

- A. Applicator's Quality Assurance: Submit list of a minimum of 3 completed projects of similar size and complexity to this Work completed within the last 5 years. Projects shall demonstrate experience working on comparable structures. Include for each project:
 1. Project name and location.
 2. Name of project Owner, include a contact name and phone number.
 3. Name of General Contractor is different than Contractor holding this contract.
 4. Name of Engineer, include a contact name and phone number.
 5. Name of coating manufacturer.
 6. Approximate area of coatings applied.
 7. Date of completion.
- B. Use only qualified journeyman painters for the mixing and application of paint on exposed surfaces. In the acceptance or rejection of installed painting, no allowance will be made for lack of skill on the part of painters.
- C. Apply paints following the recommendations in the "Applications Manual for Paint and Protective Coatings" published by McGraw-Hill.

1.04 FIELD QUALITY CONTROL

- A. Inspector's Services: The Contractor shall hire Dixon Engineering or Nelson Tank (third party satisfactory to the Owner), at no additional expense to the Owner, to perform field inspections of items 1-4 below and prepare the field inspection reports described in item 5 below:
 1. Verify coatings and other materials are as specified.
 2. Verify surface preparation and applications are as specified.
 3. Visually inspect all welds prior to coating.
 4. Verify DFT of each coat and total DFT of each coating systems are as specified using wet film and dry film gauges.
 5. Coating Defects: Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
 6. Report:
 - a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
 - b. Report nonconforming work no corrected.
 - c. Submit copies of report to Owner and Contractor.

1.05 SUBMITTALS

- A. Provide submittals in accordance with Division 1 of the Specifications. Prior to ordering and delivering paint materials to the project site, submit the following:

1. Manufacturer literature demonstrating compliance with these Specifications and indicating paint formulation, rate of coverage, recommended uses and recommended application method.
 2. Color chips for the full range of colors available in each product.
- B. The paint products indicated in these Specifications establish the required standard of paint quality. Requests for substitution will not be considered.

1.06 PRODUCT HANDLING

- A. Deliver all paint materials to the job site in their original unopened containers with all labels intact and legible at time of use. Store only the approved materials at the job site. Store them in a suitable and designated area restricted to the storage of paint materials and related equipment. Use all means necessary to ensure the safe storage and use of paint materials and the prompt and safe disposal of waste. Store volatile solvents, rags and cleaning materials in a well ventilated area.
- B. Use all means necessary to protect paint materials before, during, and after application and to protect the installed work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the OWNER.

1.07 EXTRA STOCK

- A. Upon completion of the work of this Section, deliver to the OWNER an extra stock of paint equaling approximately 2% of each color and gloss used in each coating material with all such extra stock tightly sealed in clearly labeled containers that have not been previously opened.

1.08 GUARANTEE

- A. Furnish a 1-year warranty from the date of substantial completion on workmanship. Manufacturer to provide an unlimited warranty on the materials.

PART 2 - PRODUCTS

2.01 PAINT MATERIALS

- A. Provide paint materials in accordance with the paint schedules that follow the text of this Section.
- B. All paint materials for each paint system shall be the products of a single manufacturer. All paint materials and equipment shall be compatible in use: finish coats shall be compatible with prime coats, prime coats shall be compatible with the surface to be coated, and all tools and equipment shall be compatible with the coating to be applied. Thinners, when used, shall be only those thinners specifically recommended for that purpose by the manufacturer of the material to be thinned.

- C. Furnish finish paint in the colors selected by the OWNER from the manufacturer's standard available colors (a minimum of 12 colors must be available for each finish paint requiring color choice). Specially mixed colors may be required to achieve OSHA approved safety colors and to provide the piping and plumbing line colors to meet the OWNER's color scheme. The City of Ann Arbor Color Coding of Piping schedule is appended to this specification for reference.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

- A. Prior to beginning the work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this application may properly commence. Verify that paint finishes may be applied in strict accordance with all pertinent codes and regulations and the requirements of these Specifications. In the event of discrepancy, immediately notify the ENGINEER. Do not proceed with application in areas of discrepancy until all such discrepancies have been fully resolved. Application of paint materials shall be deemed to indicate acceptability of the existing surface conditions.

3.02 SURFACE PREPARATION

A. General

- 1. Prior to beginning surface preparation and painting operations, completely mask, remove, or otherwise adequately protect all hardware, accessories, machined surfaces, plates, equipment identification tags/nameplates, lighting fixtures, and all work of other trades that are not to receive the paint coating. Before applying paint, thoroughly clean and prepare all surfaces according to the specified surface preparation method. Schedule all cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- 2. Spot prime all necessary areas prior to beginning field painting.

B. Preparation of Concrete and Masonry Surfaces

- 1. The surface finishing of concrete is specified in Division 3.00 of these Specifications. Do not begin paint application until these requirements have been met and concrete has cured for at least 28 days.
- 2. Prior to painting, grind or scrape off all surface defects such as fins, protrusions, bulges, and mortar spatter. On concrete surfaces, remove non-degraded release agents, oil, wax and grease by scraping off heavy deposits and washing with hot trisodium phosphate solution (2 lbs trisodium phosphate per gallon 160°F water). After cleaning flush with warm water to remove residual cleaning solution.
- 3. Where the paint schedule calls for brush-off blast cleaning, dry sandblast concrete using silica sand passing a 16 mesh screen. Sandblast until the surface has been lightly abraded without entirely removing the surface or exposing underlying aggregate. After sandblasting, remove dust, sand and loose particles by vacuuming or blowing off with high pressure air.

C. Preparation of Metal Surfaces

- 1. Prepare metal surfaces for painting by following the method indicated on the appropriate paint schedule. Preparation methods are referenced to the Steel Structures Painting Council (SSPC) Specifications. Do not prepare metal for painting when the relative

humidity is higher than 85% or the metal is less than 5°F above the dew point. After surface preparation, thoroughly clean all surfaces of any remaining dirt, oil and grease and leave it ready to receive prime paint.

- D. Preparation of Gypsum Drywall and Plaster Surfaces
 - 1. Sand joint compound, where applied, to provide a flat, smooth surface finish. Avoid sanding that would raise the nap of adjacent paper-covered surfaces. Prior to applying primer, remove all existing wallpaper, wall paper glue, dust and foreign substances from the surfaces to be painted.
- E. Preparation of Plastic Surfaces
 - 1. Clean plastic surfaces of all dirt, oil and foreign substances using a mild solvent cleaner.

3.03 PAINT APPLICATION

- A. Apply paint in accordance with paint schedule requirements, the cited reference, all codes and regulations, and the recommendations of the paint manufacturer. Apply prime paint to metal surfaces within 24 hrs after surface preparation. Do not apply paint in areas where dust is being generated.
- B. Do not apply paint when the surrounding air temperature as measured in the shade is below 40°F or when the temperature of the surface to be painted is below 35°F. Do not apply paint when it is expected that the relative humidity will exceed 85% or that the air temperature will drop below 40°F within 18 hrs after the application of paint. Dew or moisture condensation should be anticipated and if such conditions are prevalent, delay painting until certain that the surfaces can be kept above the dew point. Follow all additional environmental limitation requirements of the paint manufacturer.
- C. Paint material mil thicknesses and numbers of coats that are indicated in the paint schedules are based on brush or roller application. Spray application of paint materials will be allowed in the field only for areas or surfaces that are very difficult to paint with brush or roller. Field spray application must be approved by the ENGINEER before its initiation. For areas that are spray painted, apply as many coats as necessary to achieve specified mil thicknesses.
- D. Allow sufficient drying time between coats of paint. During adverse weather, extend length of drying time as recommended by the paint manufacturer.
- E. Prior to applying each paint coating after the first, check mil thickness of previously applied coating(s). Correct for insufficient paint thickness by increasing the mil thickness of subsequent applications, if allowed by the paint manufacturer or by applying additional coatings to provide the specified paint thickness.
- F. Spot sand between coatings to remove paint defects visible to the unaided eye from a distance of five feet.
- G. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWAD 102.
- H. Paint system for the concrete floors shall not be applied until all other work by other trades is complete.

3.04 CLEAN UP

- A. During the progress of the work, do not allow the accumulation of empty containers or other excess items except in areas specifically set aside for that purpose. Following completion of painting in each area, promptly remove all masking and temporary protection. After paint has dried, reinstall all items removed for painting. Upon completion of this portion of the work, visually inspect all surfaces and remove paint and traces of paint from surfaces not scheduled to be painted.

SCHEDULES FOLLOW

PAINT SCHEDULE C2

SERVICE: INTERIOR CONCRETE

Surface Preparation: Surface must be dry, clean, and free from contaminants. On concrete, remove non-degraded release agents, oil, wax, and grease by washing with a hot trisodium phosphate solution. Brush off blast cleaning (concrete) SSPC SP13/ICRI CSP 2 – 4 Surface Preparation of Concrete

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Finish	H.B. Tnemec-Tufcoat Series 114	Waterborne Acrylic Epoxy	two	4-6	-	Gloss

Note: Product is self-priming on concrete

PAINT SCHEDULE C5

SERVICE: INTERIOR MASONRY

Surface Preparation: Surface must be dry, clean, and free from contaminants. On concrete, remove non-degraded release agents, oil, wax, and grease by washing with a hot trisodium phosphate solution. Brush off blast cleaning (concrete) SSPC SP13/ICRI CSP 2 – 4 Surface Preparation of Concrete

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Primer	Envirofill Series 130 Masonry Filler	Waterborne Cementous Acrylic	one	-	-	
Tnemec	Finish	H.B. Tneme-Tufcoat Series 114	Waterborne Acrylic Epoxy	two	4-6	-	Gloss

PAINT SCHEDULE C7

SERVICE: INTERIOR CONCRETE FLOORS

Surface Preparation: Surface must be dry, clean, and free from contaminants. On concrete, remove non-degraded release agents, oil, wax, and grease by washing with a hot trisodium phosphate solution. Brush off blast cleaning (concrete) SSPC SP13/ICRI 3 – 5 Surface Preparation of Concrete

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	First Coat	Series 201 Epoxoprime	Modified Polyamine Epoxy	one	6-8	-	
Tnemec	Finish Coat	Series 281 Tneme-Glaze	Modified Polyamine Epoxy	two	6-8	-	self-leveling pigmented w/ broadcast sand

Alternate Finish Coats:

1. Tnemec	Finish Coat	Series 280	Modified Polyamine Epoxy	two	6-8	-	higher viscosity leaves stippled effect
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Provide samples for Owner review
 Final selection by Owner
 Concrete floor painting shall not occur until all other work at the facility has been completed.

PAINT SCHEDULE M1

SERVICE: EXTERIOR METAL

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Shop Primer	Hi-Build Epoxoline Series 66	Polyamide Epoxy	one	3-5		
Tnemec	Field Primer	Hi-Build Epoxoline Series 66	Polyamide Epoxy	touch-up	3-5		
Tnemec	Finish	Endura-shield Series 1074	Aliphatic Acrylic Polyurethane	two	2-3		Not for immersion service

PAINT SCHEDULE M2

SERVICE: INTERIOR METAL

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Shop Primer	F.C. Typoxy Series 27	Polyamide Epoxy	one	4-6		
Tnemec	Field Primer	F.C. Typoxy Series 27	Polyamide Epoxy	touch-up	4-6		
Tnemec	Finish	H.B. Tneme- Tufcoat Series 114	Waterborne Acrylic Epoxy	one	4-6		Series 114 - Gloss

PAINT SCHEDULE M7

SERVICE: PRETREATMENT OF GALVANIZED AND NONFERROUS METALS

Surface Preparation: Prepare surfaces by sanding, abrading or using Clean N Etch as manufactured by Great Lake Laboratories or owner approved equal. SSPC-SP1 Solvent Cleaning

For all galvanized items that require touch-up painting, pretreat items as indicated in the surface preparation, then apply a zinc-rich primer to all areas requiring touch up.

For galvanized and non-ferrous metal items to be painted following pretreatment and touch-up, refer to Schedule M1 for Exterior Metal items and Schedule M2 for Interior Metal Items.

PAINT SCHEDULE P1
SERVICE: INTERIOR PLASTICS

Surface Preparation: Abrade to generate a profile for mechanical adhesion

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Primer	F.C. Typoxy Series 27	Polyamide Epoxy	one	4-6	-	
Tnemec	Finish	H.B. Tneme- Tufcoat Series 114	Waterborne Acrylic Epoxy	one	4-6	-	Series 114 - Gloss

PAINT SCHEDULE PP1

09900-16

SERVICE: PROCESS PIPING

Surface Preparation: Degreased in accordance with SSPC-SP1, SSPC-SP6 Commercial Blast Cleaning
 Steel surfaces that are to be repainted shall be commercial blast cleaned in accordance with SSPC-SP6 until at least 2/3 of each element is free of all visible residues.

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Shop Primer	F.C. Typoxy Series 27	Polyamide Epoxy	one	4-6		
Tnemec	Field Primer	F.C. Typoxy Series 27	Polyamide Epoxy	one4-6			universal rust-inhibitive primer, with compatible with finish coat specified
Tnemec	Finish	H.B. Tneme-Tufcoat Series 114	Waterborne Acrylic Epoxy	two	2-3		Series 114 - Gloss

Insulated Piping, Acrylic Coated: Apply 2 coats of an acrylic enamel at 2.0 to 2.5 dry mils per coat.

CITY OF ANN ARBOR WTP
STANDARD PAINT SCHEDULE

COLOR CODING OF PIPING

Potable Water: High Service, Transfer, & Wash Water (includes manhole covers)	Clear Sky en17 (tnemec)
Plant Pressure	PL12 (tnemec)
Non-Potable Water: River, Filter Infl. & Effl. (Includes manhole covers)	Frosted mint GB48 (tnemec)
Sludge (includes pipes, equipment and manhole covers)	Chipmunk yb23 (tnemec)
Natural Gas	Safety Yellow SC01 (tnemec)
Fire Service Water	Safety Red sc09 (Tnemec)
Compressed Air	Safety Green sc07 (tnemec)
Steam	Safety Purple sc08 (tnemec)
Used Wash Water	Light gray IN01 (tnemec)
Carbon Dioxide	White wh01 (tnemec)
valve handles and handrails indoors	Safety Orange sc03 (tnemec)
Fluoride	Hunter Green pl20 (tnemec)
Ammonia	lemonade yb16 (tnemec)
Sodium Hydroxide	Kastrel blue gr18 (tnemec)
Handrails and Platforms outside	beige yb38 (tnemec)
shafts for basins and flocs	pota-pox series beige yb38 (tnemec)
exterior tanks, containments, reservoir vents, fence	foliage en08 (tnemec)
new door frames	terra cotta en13 (tnemec)
new black doors	black IN06 (tnemec)
hot water	mountain shadow gb07 (tnemec)
	blue summit pl11 (tnemec)

END OF SECTION

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SECTION 10140 - SIGNAGE SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The CONTRACTOR shall furnish all labor, materials, equipment, and incidentals required to install signage as specified herein and as described in the drawings.

1.02 RELATED WORK

1.03 REFERENCES

- A. Federal Specifications
 - 1. QQ-A-200/8D: 6063 Aluminum alloy bar, rod, shapes, tube, and wire.
 - 2. QQ-A-250/2D: 3003 Aluminum alloy plate and sheet.

1.04 QUALITY ASSURANCE

- A. Qualifications: Each type of product specified under this Section shall be furnished by a single manufacturer who is an experienced specialist in the production of these materials.
- B. Tolerances:
 - 1. All dimensions within this Specification shall have a dimensional tolerance of plus or minus 1/16 of an inch.

PART 2 - PRODUCTS

2.01 SAFETY AND RESTRICTIVE SIGNS (S)

- A. Fixed plaque signs shall consist of 1/16-inch thick, clear matte acrylic that is sub-surface printed with the sign message prior to being laminated to a 1/8-inch thick base plate of red opaque acrylic. Plaque shall have 1 inch radius rounded corners and shall be suitable for outdoor use.
- B. Plaque lettering shall be 2 inch high, Helvetica Medium font, in all caps. Letters and symbols shall be of die-cut pressure sensitive vinyl.
- C. Plaques shall be wall mounted and shall be affixed to a shim plate with vinyl foam tape or silastic adhesive. Shim plate shall be 0.125-inch thick aluminum with pre-drilled counter sunk holes. Plate shall be mounted to the wall with stainless steel screws.
- D. Plaques shall be manufactured by Andco Industries Corporation, Vomar Products, Cooper Architectural Signs, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Building number shall be provided at each corner of the building with a building identification sign.
- B. Each man-door shall be labeled with a room identification sign.
- C. Fire equipment in the chemical room shall be labeled with a safety sign.
- D. In case of emergency signs shall be labeled with a safety sign.
- E. Signage shall be installed at the locations as directed in accordance with the manufacturer's recommendations.
- F. Damaged units or components shall be removed and replaced at no cost to the OWNER.
- G. Signage shall be cleaned to the satisfaction of the ENGINEER, using the approved methods, upon completion of the installation, and again just prior to acceptance of the project.
- H. Do not install signs until final coat paint on surface is dry.
- I. Signs shall be installed in the locations noted in drawings and describe herein.

END OF SECTION

SECTION 10200 - ALUMINUM LOUVERS AND VENTS

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section Includes:
 - 1. Fixed metal wall louvers.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS:

- A. Louver Terminology: Refer to AMCA Publication 501-85 for definitions of terms for metal louvers not otherwise defined in this Section, or referenced standards.

1.03 PERFORMANCE REQUIREMENTS:

- A. Structural Performance: Design, ENGINEER, fabricate, and install exterior metal wall louvers to withstand the effects of loads and stresses from wind and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter, and permanent damage to fasteners and anchors:
 - 1. Wind Load: Uniform pressure (velocity pressure) of 20 pounds per square foot acting inwards or outwards.
 - 2. Normal thermal movement is defined as that resulting from the following maximum change (range) in ambient temperature. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
 - a. Temperature Change (Range): 100 degrees F (55.5 degrees C).
- B. Air Performance, Water Penetration, and Air Leakage Ratings: Provide louvers complying with performance requirements indicated as demonstrated by testing manufacturers' stock units, of height and width indicated, according to Air Movement and Control Association (AMCA) Standard 500.

1.04 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Drawings of louver units and accessories. Include plans, elevations, sections, and details showing profiles, angles, spacing of louver blades, unit dimensions related to wall openings and construction, free areas for each size indicated, and profiles of frames at jambs, heads, and sills.
 - 2. Product data for each product indicated.
 - 3. Wiring diagrams detailing wiring for power and control systems, differentiating clearly between manufacturer-installed wiring and field-installed wiring.
 - 4. Samples for verification purposes of each type of metal finish required, prepared on 6-inch square metal samples of same thickness and alloy indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

1.05 QUALITY ASSURANCE:

- A. Single Source Responsibility: Obtain louvers and vents from a single source where alike in one or more respects with regard to type, design, and factory-applied color finish.
- B. Codes and Standards:
 - 1. Qualify welding processes and welding operators in accordance with D1.2, "Structural Welding Code - Aluminum," and D1.3, "Structural Welding Code - Sheet Steel."
 - a. Certify that each welder employed in unit of Work of this Section has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
 - b. Testing for recertification is CONTRACTOR's responsibility.
 - c. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures.

1.06 PROJECT CONDITIONS:

- A. Field Measurements: Check actual louver openings by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate Fabrication schedule with construction progress to avoid delay of Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Louvers:
 - a. Airolite Co.
 - b. American Warming and Ventilating, Inc.
 - c. Construction Specialties, Inc.
 - d. Greenheck
 - e. Industrial Louvers, Inc.
 - f. Ruskin Manufacturing Division, Phillips Industries, Inc.
 - 2. Cottonwood Seed Filters:
 - a. Air Solution Company, The Newway Company dba

2.02 MATERIALS:

- A. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer to produce required finish.
- B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- C. Fasteners: Of same basic metal and alloy as fastened metal, unless otherwise indicated. Do not use metals which are corrosive or incompatible with materials joined.
 - 1. Use types, gauges, and lengths to suit unit installation conditions.
 - 2. Use Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.

- D. Anchors and Inserts: Of type, size, and material required for type of loading and installation indicated. Use nonferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.
- E. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

2.03 FABRICATION, GENERAL:

- A. Fabricate louvers and vents to comply with requirements indicated for design, dimensions, materials, joinery, and performance.
- B. Preassemble louvers in shop to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of size indicated with allowances made for fabrication and installation tolerances of louvers, adjoining construction, and perimeter sealant joints.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not further apart than recommended by manufacturer, or 72 inches on center, whichever is less. At horizontal joints between louver units, provide horizontal mullions except where continuous vertical assemblies are indicated.
- G. Provide sill extensions and loose sills made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.
- H. Join frame members to one another and to fixed louver blades as follows, unless otherwise indicated, or size of louver assembly makes bolted connections between frame members necessary:
 - 1. With fillet welds concealed from view, and concealed from view mechanical fasteners only where required for continuous assemblies.

2.04 FIXED EXTRUDED ALUMINUM WALL LOUVERS:

- A. Horizontal, Drainable Fixed Blade Louvers: Extruded aluminum frames and louver blades, complying with the following requirements:
 - 1. Louver Depth: 4 inches, unless otherwise indicated.
 - 2. Frame Type: Channel flange, unless otherwise indicated.
 - 3. Frame Thickness: 0.125 inch, unless otherwise indicated.
 - 4. Louver Blade Thickness: 0.125 inch, unless otherwise indicated.
 - 5. Louver Blade Profile: Plain blade with no center baffle.
 - 6. Louver Blade Angle: 45 degrees, unless otherwise indicated.

7. Performance Requirements: As follows, determined by testing units 48 inches wide by 48 inches high per AMCA Standard 500:
 - a. Louver Free Area: See schedule.
 - b. Static Pressure Loss: See Schedule.
 - c. Water Penetration: See Schedule.
8. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.05 LOUVER SCREENS:

- A. Provide each exterior louver with louver screens complying with the following requirements:
 1. Screen Location for Fixed Louvers: Interior face unless otherwise indicated.
 2. Screening Type: Bird screening on all exhaust louvers unless otherwise indicated.
 3. Screening Type: Insect screening on all intake louvers unless otherwise indicated.
 4. See Article "Cottonwood Seed Filters" for exterior filter materials. The "Cottonwood Seed Filters are in addition to the screening above.
- B. Secure screens to louver frames with stainless steel machine screws, spaced at each corner and at 12-inch on center between.
- C. Louver Screen Frames: Fabricate screen frames with mitered corners to louver sizes indicated and to comply with the following requirements:
 1. Metal: Same kind and form of metal as indicated for louver frames to which screens are attached.
 - a. Reinforce extruded aluminum screen frames at corners with clips.
 2. Finish: Same finish as louver frames to which louver screens are attached.
 3. Type: Rewireable frames with a driven spline or insert for securing screen mesh.
- D. Louver Screening for Aluminum Louvers: Fit aluminum louver screen frames with screening covering louver openings and complying with the following requirements:
 1. Bird Screening: 1/4-inch square mesh formed with 0.080-inch-diameter aluminum or stainless steel wire.
 2. Insect Screening: 18 by 16-mesh formed with 0.012-inch-diameter aluminum or stainless steel wire.

2.06 COTTONWOOD SEED FILTERS

- A. Provide Heavy Duty Commercial Grade Cottonwood filters on all intake louvers, weather hood intakes, and where noted on the drawings. Filters shall be located on the exterior of the louver or intake.
- B. Filter Screen Media: Filter Screens are specifically engineered for high volume / high velocity HVAC air flow applications including: evaporative condensers, AHU's, louvers and other HVAC applications. Filters must be specifically designed to stop airborne debris such as cottonwood seed, pine needles, insects, leaves, grass, birds, construction debris and other airborne matter.
- C. Construction: The mesh filter screen shall comprised of a single ply, non-porous, nonelectrostatic HVAC mesh that has a smooth non-stick" (non-textured), UV resistant vinyl coating over a polyester fiber core. Filters shall have a "rip-stop" characteristic using a coating bond at intersect points with no additional fibers intersecting the mesh openings. This ensures uniformity in airflow throughout the life of the filter and helps prevent snagging / entanglement of airborne debris and prevents tearing and running in the event of a cut or puncture. Filters shall include a heavy duty, fiber reinforced vinyl outer binding wrapped around the edge on all sides to provide a 1.125" face & back

binding with two rows of double lock stitching using weather & UV resistant cording for high strength & durability.

1. Filters must be cleanable without removal from the equipment and require only a broom, brush, shop vacuum or rinsing with a garden hose.
2. Electrostatic and polypropylene filters are not acceptable.

D. Mounting System: Provide clear anodized aluminum track, stainless steel track mounting screws; with quick release spin knob fasteners with stainless steel slide bolt & snug nuts compatible with the track system. Track system shall be installed along the complete perimeter of the louver or intake protected.

1. The use of bungee cord fasteners, magnetic fasteners, screws, stayput fasteners, Velcro fasteners and jack-nut fasteners are not acceptable.

E. Certified Performance: Filter air flow performance must be less than or equal to 0.004" w.g. @ 100 fpm, 0.042" w.g. @400 fpm, and 0.091" w.g. @ 600 fpm. (Mesh not specifically engineered for high volume / high velocity air movement in a mechanical application is not acceptable – this includes window screen, pet screen, shade screen, etc.)

2.07 FINISHES:

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Finish louvers after assembly.

2.08 ALUMINUM FINISHES:

A. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.

B. Class I Color Anodized Finish: AA-M12C22A42/A44 (Mechanical Finish: As fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, film thicker than 0.7 mil with integral color or electrolytically deposited color) complying with AAMA 606.1 or AAMA 608.1.

1. Color: As selected by ENGINEER from within standard industry colors and color density range.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Site.

3.02 INSTALLATION:

A. Locate and place louver units plumb, level, and in proper alignment with adjacent work.

- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective Work. Return items which cannot be refinished in field to shop, make required alterations, and refinish entire unit, or provide new units.
- F. Protect nonferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry, or dissimilar metals.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where required to make louver joints weathertight. Comply with Section 07900, Joint Sealers for sealants applied during installation of louver.

3.03 ADJUSTING AND PROTECTION:

- A. Protect louvers and vents from damage of any kind during construction period, including use of temporary protective coverings where needed and approved by louver manufacturer. Remove protective covering at time of Substantial Completion.
- B. Restore louvers and vents damaged during installation and construction period so that no evidence remains of correction Work. If results of restoration are unsuccessful, as judged by ENGINEER, remove damaged units and replace with new units.
- C. Clean and touch-up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.04 CLEANING:

- A. Periodically clean exposed surfaces of louvers and vents which are not protected by temporary covering to remove fingerprints and soil during construction period; do not let soil accumulate until final cleaning.
- B. Before final inspection, clean exposed surfaces with water and with a mild soap or detergent not harmful to finishes. Rinse thoroughly and dry surface.

END OF SECTION

SECTION 10522 - FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section Includes: Extent of fire extinguishers, cabinets, and accessories as indicated on Drawings and Schedule.
- B. Types of products required include:
 - 1. Fire extinguishers.
 - 2. Mounting brackets.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS:

- A. Fire Extinguishers: Refers to units which can be hand carried, as opposed to those which are equipped with wheels or to fixed fire extinguishing systems.

1.03 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submit product data for each type of product included under this Section.
 - 2. For fire extinguisher cabinets, include roughing-in dimensions and details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type and materials, trim style and door construction, and panel style and materials.
 - 3. Submit samples of each required finish for verification purposes. Prepare samples on metal of same gauge as used for actual production run. Where normal color variations are to be expected, include two or more units in each sample set showing limits of such variations.
 - a. For initial selection of colors and finishes, submit manufacturer's color cards showing full range of standard colors available.

1.04 QUALITY ASSURANCE:

- A. Single Source Responsibility: Obtain products under this Section from one manufacturer.
- B. Codes and Standards:
 - 1. UL Listed Products: Provide new, portable fire extinguishers which are UL listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher indicated.
 - 2. FM Listed Products: Provide new, portable fire extinguishers which are approved by Factory Mutual Research Corporation for type, rating, and classification of extinguisher indicated and carry appropriate FM marking.
- C. Coordination: Verify that fire extinguisher cabinets are sized to accommodate fire extinguishers of type and capacity indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Fire Extinguishers and Accessories:
 - a. Amerex Corporation.
 - b. Badger Fire Protection.
 - c. J.L. Industries.
 - d. Kidd Frynetics.
 - e. Larsen's Manufacturing Co.
 - f. Potter Roemer, Div. of Smith Industries, Inc.
 - g. Accessory Specialties.

2.02 FIRE EXTINGUISHERS:

- A. Portable fire extinguishers shall be purchased, certified, and installed by a local supplier who has a maintenance contract on OWNER's existing installation, or can provide such a contract if none exists. Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by ENGINEER from manufacturer's standard, which comply with requirements of governing authorities. The fire extinguishers shall have a minimum 1-year warranty and shall include inspection and recharging at end of 1 year.
 - 1. All units shall comply with Underwriter's standards. Valves shall be aluminum or brass.
 - 2. Extinguishers shall be red in color to conform to OSHA standards, sized as noted on Fire Extinguisher Schedule appended, and shall be made of all metal for tank, valve, and valve stem.
 - 3. Extinguisher shall be mounted with wall-mount bracket unless cabinets are called for on Fire Extinguisher Schedule.
 - 4. Fill and service extinguishers to comply with requirements of governing authorities and manufacturer's requirement.
 - 5. Abbreviations indicated below to identify extinguisher types relate to UL classification and rating system and not necessarily to type and amount of extinguishing material contained in extinguisher.
- B. Stored Pressure Water Mist Type: UL-rated 2-A:C, 2-1/2-gallon nominal capacity, in enameled steel container with pressure indicating gauge, for Class A and Class C fires.
- C. Carbon Dioxide Type: UL-rated 10-B:C, 15-pound nominal capacity, in manufacturer's standard enameled metal container, for Class B and Class C fires.
- D. Dry Chemical Type: UL-rated 40-B:C, 10-pound nominal capacity, in enameled steel container, for Class B and Class C fires.
- E. Multi-Purpose Dry Chemical Type: UL-rated 2-A:10-B:C, 5-pound nominal capacity, in enameled steel container, for Class A, Class B, and Class C fires.
- F. Multi-Purpose Dry Chemical Type: UL-rated 4-A:60-B:C, 10-pound nominal capacity, in enameled steel container, for Class A, Class B, and Class C fires.

- G. Clean-Agent Type in Brass Container: UL-rated 2-A:10:B:C, 15-pound nominal capacity, in chrome plated brass container, for Class A, Class B, and Class C fires.

2.03 MOUNTING BRACKETS:

- A. Provide manufacturer's standard bracket designed to prevent accidental dislodgement of extinguisher, of sizes required for type and capacity of extinguisher indicated in manufacturer's standard plated finish.
 - 1. Provide brackets for extinguishers not located in cabinets.
 - 2. Provide brackets for extinguishers not located in cabinets and for those located in cabinets, where indicated or required.

2.04 FIRE EXTINGUISHER CABINETS:

- A. Provide fire extinguisher cabinets where indicated, of suitable size for housing fire extinguishers of types and capacities indicated.
- B. Construction: Manufacturer's standard enameled steel box, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld all joints and grind smooth. Miter and weld perimeter doorframes.
- C. Cabinet Type: Suitable for mounting conditions indicated of the following types:
 - 1. Surface-Mounted: Cabinet box (tub) fully exposed and mounted directly on wall.
- D. Trim Style: Fabricate trim in one piece with corners mitered, welded, and ground smooth.
 - 1. Exposed Trim: One-piece combination trim and perimeter doorframe overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - a. Square Edge Trim: Square edges with backbend depths as follows: 1/4 to 5/16 inch.
 - a. Trim Metal:
 - 1) Of same metal as door.
- E. Door Material and Construction: Manufacturer's standard door construction, of material indicated, coordinated with cabinet types and trim styles selected.
 - 1. Enameled Steel: Manufacturer's standard flush, hollow-steel door construction with tubular stiles and rails.
 - 2. Door Glazing: Tempered float glass, complying with FS DD-G-1403, Grade B, Style I, Type I, Quality q3, class as indicated below:
 - a. Clear glass, Class 1 (transparent).
- F. Door Style: Manufacturer's standard design as indicated below.
 - 1. Full-Glass Panel: Float glass, 1/8-inch thick.
- G. Door Hardware: Provide manufacturer's standard door operating hardware of proper type for cabinet type, trim style, and door material and style indicated. Provide either lever handle with cam action latch, or door pull, exposed or concealed, and friction latch. Provide concealed or continuous type hinge permitting door to open 180 degrees.

2.05 FACTORY FINISHING OF FIRE EXTINGUISHER CABINETS:

- A. Comply with NAAMM, "Metal Finishes Manual," for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products are assembled. Protect cabinets with plastic or paper covering prior to shipment.
- B. Painted Finishes: Provide painted finish to comply with requirements indicated below for extent, preparation, and type:
 - 1. Extent of Painted Finish: Apply painted finish to both concealed and exposed surfaces of cabinet components, except where other than a painted finish is indicated.
 - 2. Color: Provide color or color matches indicated, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard colors.
 - 3. Preparation: Clean surfaces of dirt, grease, and loose rust or mill scale.
 - 4. Baked Enamel Finish: Immediately after cleaning and pre-treatment, apply cabinet manufacturer's standard baked enamel finish system to the following surfaces:
 - a. Interior of cabinet.
 - b. Exterior of cabinet except for those surfaces indicated to receive another finish.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install items included under this Section in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.
 - 1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
 - 2. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer's instructions.
 - 3. Where exact location of surface-mounted cabinets and bracket-mounted fire extinguishers is not indicated, locate as directed by ENGINEER.
 - 4. Mount bracket-mounted fire extinguishers weighing 40 pounds or less at 4'-6" above finish floor to the top of the fire extinguisher; for those weighing more than 40 pounds, at 3'-6" above finish floor to the top of the fire extinguisher.

3.02 IDENTIFICATION:

Identify existence of fire extinguisher in cabinet with lettering spelling "FIRE EXTINGUISHER" applied to door by process indicated below. Provide lettering to comply with requirements indicated for letter style, color, size, spacing, and location, or if not otherwise indicated, as selected by ENGINEER from manufacturer's standard arrangements.

- 1. Application Process:
 - a. Silk Screen.
 - b. Engraved.
 - c. Etched.
- B. Identify bracket-mounted extinguishers with red letter decals spelling "FIRE EXTINGUISHERS" applied to wall surface. Letter size, style, and location as selected by ENGINEER.

FIRE EXTINGUISHER SCHEDULE

Room No.	Location	Bracket	Cabinet	Type and Quality				Remarks
				Clean Agent 2A-10BC	Dry Chemical 4A-60BC	CO ₂ 10BC-15	Water-Mist 2A-C	
	Mechanical / Electrical Rooms		X			2		
	Pump Rooms		X			3		

END OF SECTION

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SECTION 13281 – HAZARDOUS MATERIALS ABATEMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for working with lead-containing materials (LCM), during any of the following operations:
 - 1. Demolition of Lead-Containing Materials (LCM): Includes razing a building or any portion of a building or piece of equipment with LCM.
 - 2. Incidental Removal or Disturbance of Lead-Based Paint (LBP): This includes activities such as sanding and scraping for paint preparation activities.
 - 3. Removal of Lead-Based Paint (LBP): Complete removal of LBP from substrate, typically prior to torch cutting for demolition activities.
- B. Extent of known LCM is as follows:
 - 1. Yellow Generator / Engine.
 - 2. Green Right Angle Gear Drive.
 - 3. Piping of Blue, Gray and Black color.

1.02 RELATED SECTIONS

- A. Demolition and removal of items not containing lead as a component is included in Division 02 Section "Selective Demolition."

1.03 DEFINITIONS

- A. The term "Lead-Based Paint" (LBP) is identified as paint or other surface coating such as varnish, sealer or stain containing lead in any detectable amount.
- B. The term "Incidental Removal or Disturbance of Lead-Based Paint" indicates one or more of the following operations:
 - 1. Scraping, hand sanding, or otherwise removing loose LBP from existing surfaces scheduled to remain in place.
- C. The term "Demolition of LCM" refers to cutting, drilling, abrading, demolishing, or otherwise disturbing building elements coated with LBP or containing lead.
- D. The term "Lead-Containing Materials" (LCM) is identified as construction debris coated with lead-based paint or other materials containing lead, such as x-ray shielding.
- E. The term "Critical Barrier" indicates the perimeter of the enclosure within which lead disruption/removal work takes place. Critical Barriers may include existing floor, wall, and ceiling structures, as well as constructed partitions, closures and seals.
- F. The term "Project Site" indicates the limits of the Project Site as indicated on drawings or by provisions of this specification.
- G. The term "Work Area" indicates the area within the Critical Barrier.

- H. The term “Action Level” means exposure to an airborne concentration of lead of 30 micrograms per cubic meter of air calculated as an 8-hour time-weighted average (TWA).
- I. The term “Exposure Assessment” means a determination of employee exposures for a given task measured by air monitoring. The Assessment must meet the criteria for objective data as outlined in the MIOSHA/OSHA Lead in Construction Standard (MIOSHA Part 603, R325.51992 and 29 CFR 1926.62).
- J. The term “OSHA PEL” stands for the Permissible Exposure Limit established by the Occupational Safety and Health Administration for lead exposure. The OSHA PEL refers to an airborne concentration of lead of 50 micrograms per cubic meter of air calculated as an 8-hour time-weighted average (TWA).
- K. The abbreviation “TCLP” stands for Toxicity Characteristic Leaching Procedure and refers to one of the tests to determine if waste is considered a Hazardous Waste or non-hazardous solid waste.
- L. The term “Hazardous Waste” refers to a listed waste or any solid or liquid waste with one or more of the following characteristics: toxic, corrosive, flammable, explosive, combustible, oxidizer, pyrophoric, unstable (reactive) or water - reactive.
- M. The term “Non-Hazardous Waste” refers to any solid or liquid waste not exhibiting characteristics of Hazardous Waste.

1.04 SUBMITTALS

- A. Exposure Assessment Documentation: Submit to all information used to document previous employee exposure assessments, if available. If not available, conduct an initial exposure assessment at the start of the project.
- B. Written Compliance Plan: Submit a Written Compliance Plan incorporating all requirements in the MIOSHA Lead in Construction Standard. Also indicate type of containment and method of liquid waste capture to be established if water is utilized for removal.
- C. Health and Safety Requirements: Submit the following information for each employee that will conduct lead disturbance on the job site:
 - 1. Respiratory Protection Program.
 - 2. Proof of current fit test for respirator that will be worn on Project Site.
 - 3. Proof of medical surveillance for respirator usage and lead work.
 - 4. Proof of lead awareness training in accordance with section 1.5. QUALITY ASSURANCE.
- D. Prepare a written schedule for each operation expected to disturb/remove LCM, indicating the following:
 - 1. Type of work to be performed, such as cutting, demolition, paint removal, or other action.
 - 2. Location of work to be performed.
 - 3. Proposed starting date and time.
 - 4. Proposed working hours.
 - 5. Proposed duration.

1.05 QUALITY ASSURANCE

- A. Personnel involved in the disturbance of LCM shall be trained in accordance with the requirements of the MIOSHA Lead in Construction Standard, including:
 - 1. The content of the MIOSHA Lead in Construction Standard and its appendices;
 - 2. The specific nature of the operations which could result in exposure to lead above the action level;
 - 3. The purpose, proper selection, fitting, use, and limitations of respirators;
 - 4. The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females and hazards to the fetus and additional precautions for employees who are pregnant);
 - 5. The engineering controls and work practices associated with the employee's job assignment including training of employees to follow relevant good work practices;
 - 6. The contents of any compliance plan in effect;
 - 7. Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician; and
 - 8. The employee's right of access to records under 29 CFR 1910.20.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 HEALTH AND SAFETY REQUIREMENTS

- A. General: Determine employee exposure to lead in air as required in MIOSHA Lead in Construction Standard.
- B. Exposure Assessment: If the Contractor has made a previous Exposure Assessment that is representative of the task to be performed on-site, the Contractor may rely on this data and determine the need for personal protective equipment and work practice controls based upon this data, if approved by the City of Ann Arbor project manager.
- C. Job requirements: When the Contractor does not have an Exposure Assessment or the Assessment is determined to be insufficient, the Contractor must conduct personal air monitoring in accordance with the MIOSHA Lead in Construction Standard and follow the requirements below which are outlined by job task until monitoring determines otherwise:
 - 1. Manual demolition, scraping, sanding, heat gun application, power tool cleaning with HEPA dust collection system, spray painting with LCM:
 - a. Use of 1/2 mask respirator with HEPA filters.
 - b. PPE.
 - c. Medical surveillance.
 - d. Use of changing room.
 - e. Use of handwashing facilities.
 - f. Provision of lead awareness training.

2. Using lead mortar, lead burning, rivet busting, power tool cleaning without HEPA collection, cleaning up with dry expendable abrasives, removing or relocating enclosure:
 - a. Loose fitting PAPR with HEPA or supplied air respirator.
 - b. PPE.
 - c. Medical surveillance.
 - d. Use of changing room.
 - e. Use of handwashing facilities.
 - f. Provision of lead awareness training.
3. Abrasive blasting, welding, using cutting torch, burning
 - a. Supplied air respirator or SCBA.
 - b. PPE
 - c. Medical surveillance.
 - d. Use of changing room.
 - e. Use of handwashing facilities.
 - f. Provision of lead awareness training.

3.02 PREPARATION

- A. General: Prepare Work Areas in a manner that will protect Owner's personnel and property, and the visiting public, from contact with LCM. Prior to beginning work, confirm starting date and time with Owner. Do not begin work that will disturb LCM without Owner's approval.
- B. Preparing Building Exteriors: Ensure adequate measures are in place to limit airborne lead content below the Action Level of 30 ug/m³ (micrograms per cubic meter) adjacent to the Work Area.
 1. Erect barricades and install warning tape or signs as necessary to prevent inadvertent exposure of passersby to LCM in all forms, including, but not necessarily limited to dust, particles, and fumes.
 2. Completely cover grounds and vegetation with minimum 8-mil thick polyethylene sheets with joints between sheets lapped and taped; with one edge taped to adjacent building surfaces below area of work; and with free ends secured in position with stakes, tie-down lines or weights. Cover sufficient ground area to capture wind-blown chips, dust and particles.
- C. Preparing Building Interiors: Ensure adequate measures are in place to protect building occupants from exposure to airborne lead dust, particles, fumes or other LCM exceeding the Action Level of 30 ug/m³ (micrograms per cubic meter) lead content in air. Adequate measures shall include, but are not necessarily limited to, construction of Critical Barriers and/or establishment of negative pressure within Work Area.
 1. Seal off openings and penetrations into the Work Area. Provide temporary dust barriers consisting of at least polyethylene plastic sheet on wood studs. Lap and tape joints of plastic sheeting to prevent dust, particles, fumes, and other forms of lead debris from leaving the enclosed area.
 2. Discontinue building ventilation within the Work Area and seal off ventilation supply and return or exhaust diffusers, grilles or openings.

3. Post warning signs at all entrances to the Work Area that state the following, as required in MIOSHA Lead in Construction Standard:
WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

3.03 WORK PRACTICES

- A. General: Perform any removal, demolition or disturbance of LCM in compliance with the following requirements:
 1. Restrict access to Work Area to essential personnel.
 2. Use moist-removal methods and/or HEPA vacuuming where applicable. Do not over-saturate the Work Area.
 3. Any debris generated must be cleaned up immediately before it can be tracked into other areas.
 4. Remove contaminated clothing and personal protective equipment before leaving the Work Area, or Work Area enclosure, as applicable.
 5. If the Action Level is exceeded outside the Work Area, discontinue work and modify Critical Barrier, or perform other modifications of methods or materials as required to reduce the lead contamination below the Action Level.
 6. Prohibit eating, drinking, and smoking in the Work Area.
- B. Incidental Removal of LBP: Remove paint from building surfaces by hand scraping and sanding; or through the use of fluid-applied chemical strippers designed to dry into a solid polymeric sheet and peel off with paint encapsulated. Hand-scraping and sanding must be used in conjunction with moist-removal methods using misted water. Leave moist paint dust and chips in place to air dry before collection.
 1. Wet methods (including power-washing) that use amounts of water that can drip, spill, or leak onto the ground, or onto or into other adjacent surfaces are prohibited unless approved by the City of Ann Arbor project manager.
 2. Dry removal methods (including sand blasting, power sanding, and other methods relying on high velocity mechanical abrasion) that create airborne fine particulate waste materials are prohibited unless specifically reviewed and approved by City of Ann Arbor project manager.
 3. Prior to torch-cutting building elements containing LBP, remove paint within four inches of centerline of cut in accordance with requirements of this Section.
- C. Removal of Solid Lead Sheetting: Remove and stockpile solid lead sheet materials in a manner that will not result in the contamination of Work Area or Project Site. Remove sheet products in the largest sections possible. Do not unnecessarily cut or abrade lead sheet materials. Provide minimum 8-mil thick plastic sheet covering between solid lead stockpiles and walls, floors, paving or ground as applicable.
 1. Do not separate lead sheet materials that are adhesively laminated to gypsum substrates. Remove and dispose as lead hazardous waste all gypsum board with lead laminate attached.

3.04 DISPOSAL

- A. Lead Painted Demolition Debris and Lead Paint Chips: In order to determine proper disposal of waste removed from the site, perform Toxicity Characteristic Leaching Procedure (TCLP) testing of LCM waste. If TCLP testing shows the waste to be nonhazardous, the waste can be disposed of as normal construction demolition debris. If waste is classified as Hazardous dispose of material as hazardous waste at an accepting landfill.
 - 1. When storing waste containers on-site, ensure that soil, ground water, and drains or sewers within the storage area are protected from possible contamination. Keep containers secure and tightly closed at all times, except when adding waste.
 - 2. Keep lead waste segregated from other waste. Do not co-mingle waste. **DO NOT MIX LIQUID AND SOLID WASTE.**
 - 3. Place appropriate labels on all containers. Provide all information required on the label; mark labels using indelible ink.

3.05 CLEAN UP

- A. Upon completion of LCM or LBP removal and disposal operations, clean all surfaces within the Work Area before it can be tracked into other areas, including, but not necessarily limited to the following:
 - 1. Siding.
 - 2. Steel support structures.
 - 3. Floors and ground.
 - 4. Walls.
 - 5. Window sills.
 - 6. Trim.
 - 7. Ledges and projections.
- B. For projects within building interior spaces, use a HEPA filtered vacuum for removal/elimination of dust, particulates, and debris.
 - 1. Brushing, brooming and other dry methods that generate airborne dust are prohibited.
- C. Remove and dispose of wash water and HEPA filters as Hazardous Waste.
- D. Remove and dispose of all solid waste used for protection and clean-up as Non-Hazardous Waste as indicated in Section 3.4, "Disposal of Non-Hazardous LCM from Demolition/Renovation Activities".
- E. Field Testing: The Owner may visually inspect and/or test the Project Site for evidence of remaining lead contamination. Return to Project Site and, at no additional cost to Owner, re-clean areas found to be contaminated.

END OF SECTION

SECTION 13341 - METAL BUILDING SYSTEMS

GENERAL - The products, materials and assemblies, including anchorage shall comply with project specific calculated design pressures and to the Michigan Building Code (Code), including wind-borne debris region criteria and shall be designed by the Manufacturer and installed by the CONTRACTOR to meet these requirements. Where a conflict occurs between the requirements stated in this document and the Code, the more stringent requirement shall apply. All products required by the Code to have product approval shall be in compliance with the Michigan Building Code.

All wall panels shall be corrugated metal panels with concealed fasteners, pre-insulated metal with roll-formed exterior and interior faces chemically bonded to a continuously foamed-in-place polyurethane core. Panels shall be as manufactured by the pre-engineered metal building. Panels shall be factory finished with a 70% PVF fluoropolymer finish. The finished wall system shall provide a minimum R-Value of 20.

Roof Panels shall be concealed fastener, pre-insulated metal, roll-formed exterior and interior faces chemically bonded to a continuously foamed-in-place polyurethane core. Panels shall be as manufactured by the pre-engineered metal building manufacturer or as approved for use with their building system. Panels shall be factory finished with a 70% PVF fluoropolymer finish. The finished roof panel system shall provide a minimum R-Value of 37. Fasteners / screws through roof panels shall be concealed and not visible in the ceiling from the interior of the building.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A Section Includes:
 - 1. Structural-steel framing.
 - 2. Foam-insulated core metal roof panels.
 - 3. Foam-insulation-core metal wall panels.
 - 4. Thermal insulation.
 - 5. Accessories.

1.03 SUBMITTALS

- A. Product Data: For each type of metal building system component. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - 1. Structural-steel-framing system.
 - 2. Foam-insulated core metal roof panels.
 - 3. Foam-insulation-core metal wall panels.
 - 4. Flashing and trim.
 - 5. Accessories.

- B. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work. All structural drawings and calculations provided shall be signed and sealed by a registered professional ENGINEER in the state of Michigan.
1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates before foundation work begins. Include a plan view showing the building columns, girt lines, base plate locations, and location, diameter, and projection of anchor bolts required to attach metal building to foundation. Indicate column reactions at each location for each load case as required by ASCE 07-05 for verification of the foundation design by the ENGINEER of Record.
 2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
 3. Metal Roof and Wall Panel Layout Drawings: Show layouts of metal panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work.
 - a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
 - b. Show wall-mounted items including doors, windows, louvers, and lighting fixtures.
 - c. Show pick points and associated point loads for lifting lugs.
 4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:8) :
 - a. Flashing and trim.
 - b. Roof ventilators.
 - c. Louvers.
 - d. Exhaust Fans
 - e. Piping, equipment and miscellaneous utility support connections to purlins, girts and framing.
- C. Samples for Initial Selection: For units with factory-applied color finish.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:
1. Metal Panels: Nominal 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other panel accessories
 2. Flashing and Trim: Nominal 12 inches (300 mm) long. Include fasteners and other accessories.
 3. Vapor-Retarder Facings: Nominal 6-inch- (150-mm-) square Samples.
 4. Windows: Full-size, nominal 12-inch- (300-mm-) long frame Samples showing typical profile.
 5. Accessories: Nominal 12-inch- (300-mm-) long Samples for each type of accessory.
- E. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.
1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 2. Keying Schedule: Detail OWNER's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

- F. Delegated-Design Submittal: For metal building systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional ENGINEER responsible for their preparation.
- G. Qualification Data: For qualified erector and manufacturer .
- H. Manufacturer Accreditation: Statement that metal building system and components were designed and produced by a manufacturer accredited according to the International Accreditation Service's AC472.
- I. Welding certificates.
- J. Metal Building System Certificates: For each type of metal building system, from manufacturer.
 - 1. Letter of Design Certification: Signed and sealed by a qualified professional ENGINEER IN THE STATE OF MICHIGAN. Include the following:
 - a. Name and location of Project.
 - b. Order number.
 - c. Name of manufacturer.
 - d. Name of CONTRACTOR.
 - e. Building dimensions including width, length, height, and roof slope.
 - f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
 - g. Governing building code and year of edition.
 - h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, auxiliary loads, and point loads for lifting lugs.
 - i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
 - j. Building-Use Category: Indicate category of building use and its effect on load importance factors.
- K. Erector Certificates: For each product, from manufacturer.
- L. Manufacturer Certificates: For each product, from manufacturer.
- M. Material Test Reports: For each of the following products:
- N. Structural steel including chemical and physical properties.
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 3. Shop primers.
 - 4. Nonshrink grout.
- O. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for insulation and vapor-retarder facings. Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.
- P. Source quality-control reports.

- Q. Field quality-control reports.
- R. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.
- S. Warranties: Sample of special warranties.

1.04 CLOSEOUT SUBMITTALS:

- A Maintenance Data: For metal panel finishes and door hardware to include in maintenance manuals.

1.05 QUALITY ASSURANCE:

- A. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.
 - 1. Accreditation: According to the International Accreditation Service's AC472.
 - 2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional ENGINEER who is legally qualified to practice in the state of Michigan.
- B. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.
- C. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.
- D. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- E. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.
- F. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings," for design requirements and allowable stresses.

- G. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.
- H. Pre-installation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to metal building systems including, but not limited to, the following:
 - a. Condition of foundations and other preparatory work performed by other trades.
 - b. Structural load limitations.

- c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
 - d. Required tests, inspections, and certifications.
 - e. Unfavorable weather and forecasted weather conditions.
2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:
- a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
 - b. Structural limitations of purlins and rafters during and after roofing.
 - c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
 - d. Temporary protection requirements for metal roof panel assembly during and after installation.
 - e. Roof observation and repair after metal roof panel installation.
3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:
- a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
 - b. Structural limitations of girts and columns during and after wall panel installation.
 - c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
 - d. Temporary protection requirements for metal wall panel assembly during and after installation.
 - e. Wall observation and repair after metal wall panel installation.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect foam-plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
 - 2. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.07 PROJECT CONDITIONS:

- A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements:

1. Established Dimensions for Foundations: Comply with established dimensions on approved anchor-bolt plans, establishing foundation dimensions and proceeding with fabricating structural framing without field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.
2. Established Dimensions for Metal Panels: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.08 COORDINATION:

- A. Coordinate sizes and locations of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Section 03300 " Cast-in-Place Concrete."
- B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and noncorrosive installation.

1.09 WARRANTY:

- A. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show 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: 20 years from date of Project Substantial Completion.
- B. Special Weather-tightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

Warranty Period: 20 years from date of Project Substantial Completion

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kingspan Insulated Standing Seam Roof Panels (900 high rib G90 galvanized R-37) and Insulated Wall Panels (series 300R 3'x42" G90 R-20) or comparable product by one of the following:
1. Kingspan Insulated Panels of North America.
 2. Butler Manufacturing Company; a BlueScope Steel company.
 3. Nucor Building Systems.
 4. VP Buildings; a United Dominion company.

2.02 METAL BUILDING SYSTEMS:

- A. Description: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.
1. Provide metal building system of size and with bay spacings, roof slopes, and spans indicated.
- B. Primary-Frame Type:
1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
- C. End-Wall Framing: Manufacturer's standard, for buildings not required to be expandable on the short face, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.
- D. End Wall Framing: Manufacturer's standard, for buildings required to be expandable on the short face, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.
- E. Secondary-Frame Type: Manufacturer's standard purlins and joists and exterior-framed (bypass) girts (refer to drawings for girt relationship).
- F. Eave Height: As shown on drawings.
- G. Bay Spacing: As shown on drawings
- H. Roof Slope: 4 inch per 12 inches.
- I. Roof System: Manufacturer's standard standing-seam sandwich panels, 4" thick, 26 gauge exterior and interior face.

Exterior Wall System: Manufacturer's standard foam-insulation-core metal smooth and corrugated wall panels, hidden fasteners 2.5" thick, 26 gauge interior and exterior face.

2.03 METAL BUILDING SYSTEM PERFORMANCE:

- A. Delegated Design: Design metal building system, including comprehensive engineering analysis by a qualified professional ENGINEER, using performance requirements and design criteria indicated.
- B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."
 - 1. Design Loads: As indicated on Drawings.
 - 2. Deflection Limits: Design metal building system assemblies to withstand design loads with deflections no greater than the following:
 - a. Purlins and Rafters: Vertical deflection of 1/240 of the span.
 - b. Girts: Horizontal deflection of 1/240 of the span.
 - c. Metal Roof Panels: Vertical deflection of 1/240 of the span.
 - d. Metal Wall Panels: Horizontal deflection of 1/240 of the span.
 - e. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
 - 3. Drift Limits: ENGINEER building structure to withstand design loads with drift limits no greater than the following:
 - a. Lateral Drift: Maximum of H/240 of the building height.
 - 4. Metal panel assemblies shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to ASTM E 1592.
- C. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. Air Infiltration for Metal Roof Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of roof area when tested according to ASTM E 1680 at negative test-pressure difference of 1.57 lbf/sq. ft. (75 Pa).
- E. Air Infiltration for Metal Wall Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa).
- F. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646 at test-pressure difference of 2.86 lbf/sq. ft. (137 Pa).
- G. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 331 at a wind-load design pressure of not less than 2.86 lbf/sq. ft. (137 Pa).

Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for Class 90

- H. Thermal Performance: Provide insulated metal panel assemblies with the following maximum U-factors and minimum R-values for opaque elements when tested according to ASTM C 1363 or ASTM C 518:
 - 1. Metal Roof Panel Assemblies:
 - a. R-Value: R-37
 - 2. Metal Wall Panel Assemblies:
 - a. R-Value: R-20.
- I. Energy Performance: Provide roof panels that are listed on the DOE's ENERGY STAR Roof Products Qualified Product List for low -slope roof products.
- J. Energy Performance: Provide roof panels with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC.

2.04 STRUCTURAL-STEEL FRAMING:

- A. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing. Framing to be G90 hot dipped galvanized.
 - 1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.
 - a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.
 - 2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
 - 3. Frame Configuration: Single gable.
 - 4. Exterior Column Type: Tapered.
 - 5. Rafter Type: Tapered.
- B. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly, G90 hot dip galvanized to comply with the following:
 - 1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
 - 2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.
- C. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, cold rolled G90 galvanized, to comply with the following:
 - 1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.
 - a. Depth: As needed to comply with system performance requirements.
 - 2. Purlins: Steel joists of depths indicated. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.
 - a. Depth: As required to comply with system performance requirements.

3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
 4. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.
 5. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.
 6. Base or Sill Angles: Minimum 3-by-2-inch (76-by-51-mm) zinc-coated (galvanized) steel sheet.
 7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
 8. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from zinc-coated (galvanized) steel sheet.
 9. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
 10. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.
- D. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.
1. Type: Straight-beam, eave type.
 2. Canopy Framing to be G90 hot dipped galvanized.
- E. Bracing: Provide adjustable wind bracing as follows:
1. Rods: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 (345); or ASTM A 529/A 529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.
 2. Cable: ASTM A 475, 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
 3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
 4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
 5. Fixed-Base Columns: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
 6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.
 7. Bracing: Provide wind bracing using any method specified above, at manufacturer's option.
 8. Bracing to be G90 hot dipped galvanized.
- F. Bolts: Provide hot-dip galvanized bolts for structural-framing components that are galvanized.
1. Metal panel attachment screws and hardware to be G90 hot dipped galvanized.
- G. Materials:
- W-Shapes: ASTM A 992/A 992M; ASTM A 572/A 572M, Grade 50 or 55 (345 or 380); or ASTM A 529/A 529M, Grade 50 or 55 (345 or 380).

1. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55 (345 or 380); or ASTM A 529/A 529M, Grade 50 or 55 (345 or 380).
2. Plate and Bar: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55 (345 or 380); or ASTM A 529/A 529M, Grade 50 or 55 (345 or 380).
3. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
4. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B or C, structural tubing.
5. Structural-Steel Sheet: Hot-rolled, ASTM A 1011/A 1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A 1008/A 1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70 (310 through 480).
6. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 (230 through 550,) or High-Strength Low-Alloy Steel (HSLAS), Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.
7. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 (230 through 550,) or High-Strength Low-Alloy Steel (HSLAS), Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.
 - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 50 or 80 (340 or 550); with Class AZ50 (AZM150) coating.
8. Joist Girders: Manufactured according to "Standard Specifications for Joist Girders," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated and required for primary framing.
9. Steel Joists: Manufactured according to "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated and required for secondary framing.
10. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts; ASTM A 563 (ASTM A 563M) carbon-steel hex nuts; and ASTM F 844 plain (flat) steel washers.
11. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
12. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with spline ends; ASTM A 563 (ASTM A 563M) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers, plain.
13. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex-head steel structural bolts with spline ends.
14. Headed Anchor Rods: ASTM F 1554, Grade 55.
 - a. Configuration: Straight.
 - b. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
 - c. Plate Washers: ASTM A 36/A 36M carbon steel.
 - d. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
 - e. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

15. Threaded Rods: ASTM A 193/A 193M .
 - a. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
 - b. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

2.05 INSULATED METAL ROOF PANELS:

- A. Trapezoidal-Rib, Standing-Seam Sandwich Metal Roof Panels : Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.
 1. Material: Zinc-coated (galvanized) steel sheet, 26 gauge nominal thickness.
 - a. Exterior Finish: 70% PVF fluoropolymer.
 - b. Color: As selected by Architect from manufacturer's full range.
 2. Clips: Manufacturer's standard, floating type to accommodate thermal movement; fabricated from zinc-coated (galvanized) steel, aluminum-zinc alloy-coated steel, or stainless-steel sheet.
 3. Joint Type: Panels snapped together.
 4. Joint Type: Mechanically seamed, folded according to manufacturer's standard.
 5. Panel Coverage: 40 inches.
 6. Panel Height: 5 inches.
 7. Uplift Rating: UL 90.
 8. Thermal Resistance Value: R-37
- B. Interior face of Metal Insulated Panels:
 1. Material: Steel coil material shall be in accordance with ASTM A755: Grade 33, G90 galvanized steel in accordance with ASTM A653 and A924.
Profile:
 2. Profile description - Shadow Line: Linear striations nominal 0.094 inches deep "V" grooves at 2 1/2 inches on center.
Texture: Non-directional stucco embossed.
Gauge: 26 gauge.
Interior Finish: PVDF finish, dry film thickness of 1.0 mil including primer.
 3. Color: Selected from the current Kingspan Insulated Panels stock color chart.
- C. Solid panels formed with vertical panel edges and flat pan between panel edges; with flush joint between panels; designed for interior side of metal wall panel assemblies and installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps.
 1. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
 - a. Exterior Finish: Siliconized polyester.
 - b. Color: As selected by Architect from manufacturer's full range.
 2. Sound Absorption: NRC not less than 1.00 when tested according to ASTM C 423.
 3. Panel Coverage: 12 inches (305 mm).
 4. Panel Height: 1.5 inches (38 mm).

D. Materials:

1. 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/A 755M.
 - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
 - c. Surface: Smooth, flat finish.

E. Finishes:

1. Exposed Coil-Coated Finish:
Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish 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.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.06 FOAM-INSULATION-CORE METAL WALL PANELS:

- A. Description: Provide factory-formed and -assembled, metal wall panels fabricated from two metal facing sheets and an insulation core foamed in place during fabrication, with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
 1. Concealed-Fastener, Foam-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
 - a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
 - b. Exterior Surface: Striated.
 - c. Panel Coverage: 40 inches nominal.
 - d. Panel Thickness: 3 inches.
 - e. Thermal-Resistance Value R-20.
- B. Panel Performance:
 1. Flatwise Tensile Strength: 30 psi (200 kPa) when tested according to ASTM C 297/C 297M.
 2. Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for seven days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
 3. Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at 200 deg F (93 deg C) according to ASTM D 2126.
 4. Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at minus 20 deg F (29 deg C) according to ASTM D 2126.

5. Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for two million cycles.
6. Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.
7. Fire-Test-Response Characteristics: Class A according to ASTM E 108. Polyisocyanurate Insulation-Core Performance:
8. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.
9. Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D 1621.
10. Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273/C 273M.

C. Materials:

1. Polyisocyanurate Insulation: Modified polyisocyanurate foam using a non-CFC blowing agent, foamed-in-place or board type as indicated, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
 - a. Closed-Cell Content: 90 percent when tested according to ASTM D 6226.
 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/A 755M.
 - b. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 - c. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
 - d. Surface: Light Embossed finish.

D. Finishes:

1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish 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.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.07 THERMAL INSULATION:

- A. Insulating Core: Polyisocyanurate (ISO) core, ASTM C591 Type IV, CFC and HCFC free, compliant with Montreal Protocol and Clean Air Act, with the following minimum physical properties:
 1. Core is minimum 90 percent closed cell when tested in accordance with ASTM D6226
 2. Foam has a density of 2.3 to 2.6 pounds per cubic foot when tested in accordance with ASTM D1622
 3. Compressive Stress when tested in accordance with ASTM D1621:
 - a. Parallel to Rise: minimum of 23 psi
 - b. Perpendicular to Rise: 23 psi
 4. Shear Stress: Minimum of 25 psi when tested in accordance with ASTM C273
 5. Tensile Stress: Minimum of 23 psi when tested in accordance with ASTM D1623
 6. Dimensional stability when tested in accordance with ASTM D2126:

- a. High Temperature Aging at 158 deg. F and 97% plus relative humidity for 28 days: less than 6 percent volume change
- b. High Temperature Aging at 200 deg. F and ambient humidity for 28 days: less than 4 percent volume change
- c. Low Temperature Aging at -10 deg. F and ambient humidity at 28 days: less than 1 percent volume change

2.08 DOORS AND FRAMES

- A. Swinging Personnel Doors and Frames: As specified in Division 8 Doors and Windows.

2.09 WINDOWS

- A. Aluminum Windows: As specified in Section 08520 "Aluminum Windows."

2.10 ACCESSORIES:

General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

- A. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
- B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
 - 2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.
 - 3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel sheet.
 - 4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - 6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch (25-mm) standoff; fabricated from extruded polystyrene.
- C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- D. Flashing and Trim: Formed from 26 gauge nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match adjacent metal panels.
1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
 2. Opening Trim: Formed from 26 gauge nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.
- E. Roof Ventilators: Gravity type, complete with hardware, flashing, closures, and fittings.
1. Roof curbs for ventilators are to be included in scope. Ventilators and all finish flashing are by others.
- F. Roof Curbs: Fabricated from minimum 0.052-inch (1.32-mm) nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal roof panels; with welded top box and bottom skirt, and integral full-length cricket; capable of withstanding loads of size and height indicated.
1. Curb Subframing: Fabricated from 0.064-inch (1.63-mm) nominal-thickness, angle-, C-, or Z-shaped metallic-coated steel sheet.
 2. Insulation: 1-inch- (25-mm-) thick, rigid type.
- G. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.
- H. Materials:
1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
 2. Fasteners for Metal Roof Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
 3. Fasteners for Metal Roof Panels: Self-drilling, zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.
 4. Fasteners for Metal Wall Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with EPDM sealing washers bearing on weather side of metal panels.
 5. Fasteners for Metal Wall Panels: Self-drilling, zinc-alloy-steel hex washer head, with EPDM sealing washers bearing on weather side of metal panels.
 6. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.

- 7. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
- K. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- L. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- M. Metal Panel Sealants:
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
 - 2. Joint Sealant: ASTM C 920; one-part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.11 SOURCE QUALITY CONTROL:

- A. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.
- B. Connections will be considered defective if they do not pass tests and inspections.
- C. Design Builder will prepare test and inspection reports.

2.12 FABRICATION:

- A. General: Design components and field connections required for erection to permit easy assembly.
 - 1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
 - 2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.
- B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.
- C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.
 - 1. Make shop connections by welding or by using high-strength bolts.
 - 2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
 - 3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
 - 4. Weld clips to frames for attaching secondary framing.
 - 5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

- D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
 - 1. Make shop connections by welding or by using non-high-strength bolts.
 - 2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.
- E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
 - 1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

PART 3 – EXECUTION

3.01 EXAMINATION:

- A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.
 - 1. Engage land surveyor to perform surveying.
- C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

- A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.03 ERECTION OF STRUCTURAL FRAMING:

- A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.
- B. The structural frame shall be braced against horizontal loads if the wall panels are in place prior to the floor slab being poured.
- C. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional ENGINEER.

- D. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.
- E. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 2. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- F. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.
- G. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.
 - 1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for bolt type and joint type specified.
 - a. Joint Type: Snug tightened or pretensioned.
- H. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.
 - 1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
 - 2. Locate and space wall girts to suit openings such as doors and windows.
 - 3. Locate canopy framing as indicated.
 - 4. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.
- I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
 - 1. Tighten rod and cable bracing to avoid sag.
 - 2. Locate interior end-bay bracing only where indicated.
- J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.
- K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.04 INSULATED CORE METAL WALL PANEL INSTALLATION, GENERAL:

- A. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.
 - 1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.
- B. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
 - 2. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.
 - 3. Install metal panels perpendicular to structural supports unless otherwise indicated.
 - 4. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
 - 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 6. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment.
 - 7. Lap metal flashing over metal panels to allow moisture to run over and off the material.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.
 - 1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements in Section 07900 "Joint Sealers."

3.05 METAL ROOF PANEL INSTALLATION:

- A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
 - 1. Install ridge and hip caps as metal roof panel work proceeds.
 - 2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.
- B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.
 - 1. Install clips to supports with self-drilling or self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.

3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
 5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Pre-drill panels for fasteners.
 6. Provide metal closures at peaks rake edges rake walls and each side of ridge and hip caps.
- C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with fasteners at each lapped joint, at location and spacing recommended by manufacturer.
1. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
 2. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
 3. At metal panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.
- D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.
- E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed 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.

3.06 METAL WALL PANEL INSTALLATION:

- A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
 2. Shim or otherwise plumb substrates receiving metal wall panels.
 3. When two rows of metal panels are required, lap panels 4 inches (102 mm) minimum.
 4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
 5. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Pre-drill panels.
 6. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 7. Install screw fasteners in predrilled holes.
 8. Install flashing and trim as metal wall panel work proceeds.
 9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated; or, if not indicated, as necessary for waterproofing.
 10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
 11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

- B. Insulated Metal Wall Panels: Install insulated metal wall panels on exterior side of girts. Attach panels to supports at each panel joint using concealed clip and fasteners at maximum 42 inches (1067 mm) o.c., spaced not more than manufacturer's recommendation. Fully engage tongue and groove of adjacent insulated metal wall panels.
 - 1. Install clips to supports with self-tapping fasteners.
Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels as weather seal.
- C. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), nonaccumulative, on level, plumb, and on location lines as indicated, and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.07 ACCESSORY INSTALLATION:

- A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 - 1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 - 2. 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 or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- C. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer

3.08 FIELD QUALITY CONTROL:

- A. Testing Agency: CONTRACTOR will engage a qualified testing agency to evaluate product.
- B. Special Inspector: CONTRACTOR will engage a qualified special inspector to perform the following tests and inspections and to submit reports. Special inspector will verify that manufacturer maintains detailed fabrication and quality-control procedures and will review the completeness and adequacy of those procedures to perform the Work.
 - 1. Special inspections will not be required if fabrication is performed by manufacturer registered and approved by authorities having jurisdiction to perform such Work without special inspection.
 - a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.
- C. Testing: Test and inspect shop connections for metal buildings according to the following:
 - 1. Bolted Connections: Bolted connections shall be snug tight tested and inspected by CONTRACTOR according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Connections will be considered defective if they do not pass tests and inspections.
- E. Design Builder will prepare test and inspection reports.

3.09 CLEANING AND PROTECTION:

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.
 - 1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- D. Touchup Painting: Cleaning and touchup painting are specified in Section 09900 "Painting."
- E. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
 - 1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- F. Doors and Frames: Immediately after installation, sand rusted or damaged areas of prime coat until smooth and apply touchup of compatible air-drying primer. Immediately before final inspection, remove protective wrappings from doors and frames.

- G. Windows: Clean metal surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installing windows.
- H. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
 - 1. Restore louvers damaged during installation and construction period so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 13410 - BASIC INSTRUMENTATION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative and procedural requirements for instrumentation installations. Administrative and procedural requirements are included in this Section to expand on requirements specified in Division 1.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each product specified.
 2. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.
 3. Digital Systems: Provide the following:
 - a. Digital equipment layouts of input and output racks showing complete module model number and addressing assignment. Layouts of port pin assignment, connection schematic indicating cable types and port addresses.
 4. Software Programs: One fully annotated printed copy of program prior to factory test, along with digital program files. In addition, provide required number of copies of latest revisions of program at time of acceptance by OWNER. Submittal of printouts, listings, and screen images shall be supplied on paper (hard copy). With concurrence of OWNER and ENGINEER, machine readable magnetic copies may be supplied in addition to printed copies as a matter of convenience. Format of magnetic media (CD/DVD or flash media) shall be as mutually agreed with OWNER.
 5. Programmable Logic Controllers: Submits lists of input and output assignments, data file structures used, and internal data points. Show points used to communicate with between PLCs and the operator interface and data collection segments. Include complete, fully annotated ladder logic diagrams complete with cross-reference listings.
 6. Operator Interface and Supervisory Control: Submit "screen dump" images of each proposed operator interface screen. Describe color schema, mouse button use, function key controls and communication protocol with PLCs. Provide a flow diagram showing screen navigation. Show sample event and alarm log outputs.
 7. Data Collection: Submit details of data structures, communications protocols, data exchange formats, sampling intervals, and file storage space management. Provide "screen dump" images of historical trending.
- B. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.
1. Where Drawings are drafted by computer equipment, CONTRACTOR shall furnish files on a disk (in PDF .pdf and AutoCAD .dwg format). These Drawings shall include changes made by Field Orders, Change Orders, Addenda, and errors discovered during start-up and acceptance.
 2. Drawings shall include terminal numbers at each wiring termination and piping termination. A complete system diagram shall be included.

- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
 - 1. Instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating equipment. Instructions shall include procedures for tests required, adjustments to be made, and safety precautions to be taken with equipment. These documents are to be submitted to ENGINEER's office.
 - 2. Provide 1 complete set of manufacturer's documentation covering programmable equipment supplied. Include hardware manuals and prints as manufacturer normally ships with programmable equipment.
 - a. Include complete software manuals for operating system, as well as manuals for any other software. Written instructions for the operations and maintenance of software shall be provided. The instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating software.
 - b. Include program listings, point/address lists, cross-reference listings, images of screens, data entry forms, and sample reports.
 - c. Manuals shall include instructions for program users and instructions for maintenance programmers.
 - d. Final, as-installed PLC and HMI programs upon completion of start-up
- D. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. National Electric Code.
 - 2. Applicable State and local requirements.
 - 3. UL listing and labeling shall be adhered to.
- C. Items covered by this Section are designated as undelivered specifically manufactured equipment for which associated progress payments will be made in accordance with this Specification.
- D. Equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that equipment furnished has been manufactured in accordance with National Electric Code and OSHA requirements.
- E. CONTRACTOR shall provide permits and licenses, observe and abide by applicable laws, regulations, ordinances, and rules of State, territory or political subdivision thereof, wherein the Work is done. CONTRACTOR shall pay fees for permits, inspections, licenses, and certifications when such fees are required.
- F. To ensure timely performance and conformance with Specifications, Project meetings shall be held at OWNER's facility once every 3 months during course of Project. Cost of such meetings shall be included.

- G. Component Requirements: For the purposes of uniformity and conformance to industry standards, signal transmission modes shall be electronic 4-20 mA DC. No other signal characteristics are acceptable, except for remote temperature detector (RTD) and thermocouple (TC) sensing circuits; 4-20 mA DC signals shall be such that devices may be wired in parallel for 1-5 volt DC as required. 1-5 volt DC mode shall be employed only within control panel enclosures.
- H. Responsibility and Coordination: Drawings and Specifications are intended to include details of a complete equipment installation for purposes specified. CONTRACTOR shall be responsible for details which may be necessary to properly install, adjust, and place in operation complete installation. Any error on Drawings or in Specifications which prevents proper operation of supplied system shall be shown correct at time of Shop Drawing submittal for approval or brought to attention of ENGINEER with or prior to submittal.
- I. CONTRACTOR shall be responsible for costs incurred to correct aforementioned errors brought to ENGINEER's attention. CONTRACTOR shall assume full responsibility for additional costs which may result from unauthorized deviations from Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Manufactured material shall be adequately packed to prevent damage during shipping, handling, storage, and erection. Material shipped to Site shall be packed in a container properly marked for identification. Blocks and padding shall be used to prevent movement.
- B. CONTRACTOR shall inspect the material prior to removing it from carrier. If damage is observed, CONTRACTOR shall immediately notify carrier so that a claim can be made. If no such notice is given, material shall be assumed to be in undamaged condition; any subsequent damage that occurs to the equipment shall be the responsibility of CONTRACTOR. Repair and replacement of damaged parts will be done at no expense to OWNER.
- C. CONTRACTOR shall be responsible for any damage charges resulting from handling of materials.

PART 2 - PRODUCTS

2.01 EQUIPMENT SUPPLIERS

- A. Subject to compliance with specified requirements, equipment suppliers shall be the following (no "or equals"):
 - 1. Commerce Controls Inc.
 - 2. Outbound Technologies
 - 3. Revere Control
 - 4. MR Systems
- B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by ENGINEER of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.

- C. Equipment Supplier: Equipment specified under Sections 13413 through 13491 and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.
 - 1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by ENGINEER.
 - 2. Direct purchase of any items in these Sections by CONTRACTOR is not in compliance with this Specification and will not be permitted.

2.02 EQUIPMENT

- A. Transmitted electronic signals to equipment of other vendors and between control panels shall be a separate isolated-floating output for each item of equipment and shall conform to ISA Standard S50.1.
- B. Enclosures shall be NEMA 12, 4, 4X, or 7 as indicated on Drawings. Intrinsically safe systems, as approved by Factory Mutual, shall be furnished when called for.
- C. No external power connections shall be allowed unless specifically called for in Specification. Where an external power source is called for, unit shall accept 120 VAC, plus or minus 10 percent power.
- D. Current-to-current converters shall be used as power boosters to provide sufficient signal power as required. It is equipment supplier's responsibility to determine under what circumstances and locations power boosters are required, provide them, and integrate them into the instrumentation system to make system function properly.
- E. Separate power supplies shall be totally enclosed with solderless terminals for connections. They shall be short circuit current limiting type that will automatically resume regulation after removal of short circuit. They shall operate from 120 volt AC, plus or minus 10 percent power. Regulated voltage shall be fixed. Units with internal trim potentiometers will be accepted.
 - 1. Instruments shall be panel-mounted or enclosed for wall mounting as shown on Drawings.
- F. Size and style of instruments are defined in Specifications. Pneumatic panel-mounted units shall match in appearance similar electronic components.
- G. Solid-state output switches, where used, shall be overvoltage transient protected and not be damaged by dI/dT or dv/dt for their design application under this Contract.
- H. Instruments shall be equipped with permanently attached identification tag. Tag shall be included on field- and panel-mounted devices. Tags shall include ENGINEER's tag identification and manufacturer's tag identification if different from ENGINEER's.
 - 1. Tags shall be either stamped metal or laminated phenolic with black letters engraved on a white background. Field-mounted devices shall have tags fastened with screws. Devices mounted in panels will be tagged inside panel on subplates or on device itself where it can be easily read.
- I. Finish on instruments and accessories shall provide protection against corrosion by elements in environment in which they are to be installed. Both the interior and exterior of enclosures shall be finished. Extra paint of each color used on material shall be provided by manufacturer for touch-up purposes.

- J. Provide equipment identification nameplates complying with Section 16075. Nameplates shall contain ENGINEER's item designation and, for indicators and transmitters, design range and units of device shown.

2.03 SOURCE QUALITY CONTROL

- A. Prior to performing any programming work and prior to program-related shop drawing review, Contractor shall schedule a meeting between OWNER, ENGINEER and system supplier (including PLC and HMI programmer), to review system configuration and functional intent. Meeting will be held at ENGINEER's Ann Arbor office. Topics to be discussed include the following:
 - 1. Sequence of operations
 - 2. Functional intent
 - 3. Alarm list
 - 4. Verify ranges, signals, etc.
 - 5. IP addresses
 - 6. Color schemes
 - 7. Schedules
- B. Control and monitoring system control panels and computer equipment, if any, shall be tested at the factory and witnessed by ENGINEER prior to shipment to Site. ENGINEER shall be given 4 weeks notice before factory test date. Factory test shall include checking for conformity to Specifications, fabrication, and nomenclature. Control and monitoring system logic and terminals shall be checked line by line and function by function in total for conformity of Drawings.
- C. Conduct preliminary testing prior to factory checkout by executing programs supplied for this Project. Exercise inputs to test logic for correct function and proper response of outputs. Verify correct interface with programs. Verify correct communications.
- D. Detailed factory testing procedures shall be developed and transmitted to ENGINEER for review prior to testing.
- E. Factory testing shall be used to validate the following:
 - 1. Communication interconnections. Proper communication between devices and software components shall be demonstrated.
 - 2. Transmission of data
 - 3. Process control capabilities
 - 4. Functional intent
 - 5. User adjustable features
 - 6. Operation under simulated malfunction conditions
 - 7. Alarm and Trend information storage
 - 8. Data Collection and Data Management Reporting shall be demonstrated.
- F. Equipment supplier shall have test equipment, interconnecting cables, and accessories available at the factory for the duration of the test. A full set of annotated logic programs and wiring diagrams with the latest revisions shall be made available to ENGINEER at factory for checking purposes. Drawings shall include wire numbers and terminal numbers.

- G. Control panels and programmable equipment shall not be shipped to Site until logic conforms to Contract requirements and information discussed at progress meetings, physical changes required by testing are made, and tags conform to factory test corrections. Equipment delivered to Site without factory test or corrections will be returned to factory at CONTRACTOR's expense.
- H. Major deficiencies identified by the Engineer shall be corrected and retested prior to completion of the factory test. Retesting shall be repeated as required until satisfactory results are obtained. Retesting shall be scheduled two (2) weeks in advance.
- I. CONTRACTOR shall include in his Bid an amount, when the instrumentation system factory test facility in this Section is more than 80 miles from ENGINEER's Ann Arbor, Michigan office. CONTRACTOR shall pay transportation for weekly trips and lodging costs for 2 members each of ENGINEER's and Owner's staff over entire factory test.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by ENGINEER.
- B. Install equipment as indicated, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices to ensure that products fulfill requirements.
- C. Elements that are supported by plumbing or piping, or that have only plumbing or piping connections shall be installed under those Sections.
- D. Plumbing, piping, or pneumatic signal connections to elements requiring such connections shall be made under those Sections. Control panels shall be installed in accordance with Division 16 Sections, with piping connections to control panels installed under Division 15 Sections.
- E. Drawings are not intended to show every detail of construction or location of piping, ductwork, or equipment. Where proper operation or construction makes it necessary or advisable to change location of piping, instrumentation equipment, air ducts, or other equipment, CONTRACTOR shall so inform ENGINEER for his approval and permission.

3.02 FIELD QUALITY CONTROL

- A. Calibrate equipment in accordance with manufacturer's instructions to ranges or set points indicated on Drawings.
- B. Installation and Start-up: Equipment supplier shall have an established service facility from which qualified technical service personnel and parts may be dispatched upon call. Such a service facility shall be no more than 6 hours travel time from Site.
 - 1. Equipment supplier shall provide an experienced, factory-trained, competent, and authorized service representative for a minimum of 4 times at Site, including once during installation, once during start-up and once during acceptance to inspect, check, and calibrate any part of system. Supplier's service representative shall revisit Site for 8 hours per day as often as necessary after

installation until trouble is corrected and equipment has passed acceptance test and is operating satisfactorily to ENGINEER.

2. Fourth trip is after equipment has been accepted and shall be used to instruct OWNER's personnel in aspects of operation and maintenance, such as fuse locations, use of controls, instruction manuals, etc. Fourth trip shall be for duration of one 8-hour day at OWNER's site.
- C. Equipment supplier shall provide two, 8-hour days of training for OWNER's personnel in aspects of operation and maintenance such as fuse of controls, fuse locations, instruction manuals, etc.
1. Training and instructions at the site shall be given by the Project Engineer assigned to the Project by the equipment supplier or other personnel as approved by ENGINEER.
- D. Digital Equipment Field Training: At conclusion of field acceptance tests, CONTRACTOR shall conduct two training sessions for OWNER's personnel in use of system.
1. Course shall be one 8 hour day in duration and shall consist of hands-on use of system as well as lectures.
 2. Written course materials shall be provided to each participant for use during instruction and to serve as a basic reference document after training.
 3. The sessions shall be separated by one week to accommodate personnel attendance scheduling.

3.03 DEMONSTRATION

- A. Upon completion of installation and calibration, demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new or repaired units, and retest to demonstrate compliance.

END OF SECTION

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SECTION 13413 - OPTICAL FIBER CABLING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Product and installation requirements for the following:
 - 1. Fiber-optic (FO) Cables.
 - 2. Fiber-optic Connectors, Couplers, and Patch Panels.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
 - 2. Product certificates, signed by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in "Quality Assurance" Article below.

1.03 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Connected Equipment Manufacturer Certifications: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications, or for systems furnished under other contracts, obtain review of the cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.
- C. UL Compliance: For cables that may be run in plenum ceilings or other air-handling spaces, provide cables tested for compliance with applicable requirements of UL Standard 910, "Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air-Handling Spaces." In addition, provide FO cables that have passed the UL VW-1 flame test.
- D. EIA/TIA Compliance: Comply with applicable requirements of EIA Standards, EIA-440, -455, -458, -475, -509, -568-b.3, and 598-a pertaining to optical fiber cable and system component construction and installation. EIA/TIA-455-61, FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR.
- E. Fiber Optics Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of fiber-optics cable systems. Installation must include installation of fiber-optics cable, fiber termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- F. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or type written onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the

background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each fiber-optics cable segment shall be labeled at each end with its respective identifier.

- G. Fiber-Optics Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all fiber cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All fiber-optics interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations. Patch panels shall be mounted such that FO cables entering and exiting the panel do not block access to other equipment/terminals in the control panel. FO cable shall be firmly secured within the control panel. Provide color diagram affixed to the panel face clearly showing fiber colors, pairs, and to/from information for each strand of the fiber cable.
- H. Patch Cords: Patch cords shall be provided for each fiber-optic port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed fiber-optic cable. Patch cord connectors shall be matched with patch panel connector type and network fiber module connector type as required.

1.04 COMMISSIONING

- A. Subsequent to hook-ups of FO system to signal sources and destination equipment, operate systems to demonstrate proper functioning. Replace malfunctioning FO cabling system items with new materials, and then retest until satisfactory performance is achieved.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. FO Cables:
 - a. Corning Infinicor SX+ Optical Fiber, or Equal, for multi-mode applications.
 - b. Corning NexCor Optical Fiber, or Equal, for single-mode applications.
 - 2. FO Connectors and Couplers:
 - a. AMP Netcon.
 - b. AT&T Network Systems.
 - c. Corning.
 - d. Honeywell, Inc.
 - e. ITT Corp.
 - f. Thomas and Betts Corp.
 - 3. FO Patch Panels:
 - a. Panduit.
 - b. Volition.
 - c. Corning

2.02 OPTICAL FIBER CABLING SYSTEMS

- A. Fabricate system using manufacturer's standard materials as indicated by published product information and in sizes, types, and performance characteristics as indicated.
- B. FO Cables: Factory fabricated, single channel, all dielectric, low loss glass type, fiber-optic multimode graded-index cables with the following operational and construction features:
 - 1. Multi-mode Fibers:
 - a. Cable Type shall be Corning ALTOS One Indoor/Outdoor Tight-Buffered Cable.
 - b. Number of Fibers: 6 minimum or as listed on Drawings.
 - c. Core Diameter: 50 microns or as listed on Drawings.
 - d. Cladding Diameter: 125 microns or as listed on Drawings.
 - e. Fiber Category: style OM2 or OM3.
 - f. Subunit Size: 2.0 mm or as listed on Drawings.
 - g. Maximum Attenuation: Less than 2.5 dB/km at 850 nm and less than 1 dB/km at 1300 nm.
 - h. Minimum Bandwidth: Greater than 1000 MHz-km.
 - i. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
 - j. Operating Temperature Range: -20 to +70 degrees C.
 - 2. Single-mode Fibers:
 - a. Cable Type shall be Corning FREEDM One Indoor/Outdoor Tight-Buffered Cable.
 - b. Number of Fibers: 6 minimum or as listed on Drawings.
 - c. Core Diameter: 9 microns or as listed on Drawings.
 - d. Cladding Diameter: 125 microns or as listed on Drawings.
 - e. Subunit Size: 2.0 mm or as listed on Drawings.
 - f. Maximum Attenuation: Less than 0.5 dB/1,350 nm.
 - g. Minimum Bandwidth: Greater than 1000 MHz-km.
 - h. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
 - i. Operating Temperature range: -20 to +70 degrees C.
- C. FO Connectors: Stainless steel, fiber-optic cable connectors, capable of terminating FO glass cables with diameters from 8 through 1,000 microns. Fabricate connectors with optical fiber, self-centering, axial alignment mechanisms. Select ST or SC style connectors as required or shown on Drawings. Connectors shall have an insertion loss of 0.5dB or better.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions with the Installer present for compliance with requirements, and other conditions affecting the performance of optical fiber cabling system. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION

- A. Install fiber-optic cables and associated equipment and devices in accordance with industry standards and manufacturer's written instructions.

- B. Install fiber-optic cable without damage to fibers, cladding, or jacket. Ensure that media manufacturer's recommended pulling tensions are not exceeded. Do not, at any time, bend cables to smaller radii than minimums recommended by manufacturer.
- C. Install FO cables simultaneously where more than one cable is being installed in same raceway. Use pulling lubricant where necessary; compound used must not deteriorate cable materials. Do not use soap. Use a pulling means, including fish tape, rope, and basket-weave grips, that will not damage media or raceway.
- D. No splices are allowed, except at indicated splice points.

3.03 GROUNDING

- A. Provide grounding connections for other system components as required by manufacturer's written instructions.

3.04 APPLICATIONS

- A. Install optical fiber cabling for project applications as detailed on drawings.

3.05 FIELD QUALITY CONTROL

- A. Testing: Testing shall be done by CONTRACTOR with at least 5 years of experience in testing fiber-optic cabling systems. CONTRACTOR shall test each fiber strand. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing.** If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER. Any fiber-optic cable left non-terminated at the discretion of OWNER, shall be tested using an adequate light source to determine that all installed strands are not damaged.
 - 1. Testing shall be completed prior to site acceptance testing. Contractor shall repair any damaged fiber connections found during testing prior to SAT.
- B. Fiber-Optics Cable: Each fiber strand shall undergo bi-directional testing for signal attenuation losses using power meter and light source. Testing shall also include Optical Time Domain Reflectometer (OTDR) at both 850 and 1,300 nanometers for all installed fiber strands.
 - 1. Recommended Test Equipment:
 - a. Multimode: Sיעor OM-100F and OS-100D or equivalent power meter and light source.
 - b. Multimode: Sיעor OTDRPlus with appropriate modules for testing.
 - 2. Tests:
 - a. Multi-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
 - b. Single-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
 - 3. Test Criteria: Signal loss of less than 10 dB through entire fiber path, including cable, couplers and jumpers.
- C. Documentation (Fiber Optic): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Fiber Test Results: The results of the fiber testing shall be entered into the form "Fiber Attenuation Tests Results." Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable. Preliminary results shall be submitted and approved prior to scheduling control panel start-up.

1. Each cable installed shall undergo complete testing in accordance with TIA/EIA TSB-67 to guarantee performance to this standard.
 2. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
 3. Test Criteria: Pass rate to conform to latest TIA/EIA Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
- D. Acceptance: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and the receipt of documentation.

3.06 CLEANING

- A. Clean optical fiber cabling and components of dirt and construction debris upon completion of installation.

END OF SECTION

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SECTION 13423 - LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Submersible level sensor.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Submersible Level Sensor:
 - a. Keller America; Acculevel.

2.02 SUBMERSIBLE LEVEL SENSOR

- A. Submersible level sensor/transmitter unit shall measure liquid depths using a fully submerged differential pressure transducer suspended in measured medium by electrical cable. Transducer shall be supplied with cable required to reach control panel from sensor location; no splices permitted.
- B. Output from sensor unit shall be 4-20 mA DC into 500 ohms. Transducer shall be loop powered.
- C. Sensor shall be intrinsically safe as required by application shown on Contract Drawings.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.
- B. CONTRACTOR to field measure all required cable lengths.

END OF SECTION

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SECTION 13424 - PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Diaphragm seals.
 - 2. Pressure to current (P/I).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Diaphragm Seals:
 - a. Ashcroft.
 - b. Trerice.
 - 2. Pressure to Current:
 - a. ABB.

2.02 DIAPHRAGM SEALS

- A. Diaphragm seals shall isolate the process measuring instruments from the process fluid. The diaphragm seal shall be of the removable type. The diaphragm seal shall be filled with liquid, compatible for the process shown to be measured on Drawings. The diaphragm seal shall be supplied with gaskets, bolts, capillary tubing, and fill fluids.

2.03 PRESSURE TO CURRENT (P/I)

- A. Pressure to current signal converter shall be 2-wire, solid-state electronic, temperature-compensated, strain gauge or capacitive type. Process pressure shall be applied to sealing diaphragm in measuring section. This pressure shall be transmitted to a measuring element connected to the electronics of the transmitter. Converter shall include a repairable circuit board mounted in a NEMA 4 housing. Transmitter shall output an isolated 4-20 mA signal proportional to pressure measurement. Adjustable electronic damping shall be provided from 0 to 16 seconds in electronically adjustable increments of 0.1 second.
- B. Positive overage protection shall be provided to 2,000 psig. Diaphragms and wetted parts shall be 316 stainless steel, except where other special alloys are required to prevent corrosion.

- C. Accuracy shall be within plus or minus 0.1 percent of calibrated span for spans from 1:1 to 15:1 of URL. Stability shall be plus or minus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.
- D. In applications where pressure transients may occur (i.e., level for elevated and ground storage tanks, pumping pressure, etc.), CONTRACTOR shall include snubbers in pressure tap line and an electronic signal time constant which will reduce pressure transients to plus or minus 1 percent of calibrated span. Time constant is to be achieved by placing it in panel providing power to pressure transmitter.
- E. Units shall be supplied with an integral digital indicator calibrated 0 to 100 percent, and in engineering units.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13426 - TEMPERATURE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Thermocouple.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. RTD Temperature Sensor:
 - a. Accutech.
 - b. Bailey.
 - c. Honeywell, Inc.
 - d. Johnson Yokogawa Corp.
 - e. Rosemount.

2.02 RTD TEMPERATURE SENSOR

- A. Microprocessor-based temperature transmitter shall convert an RTD temperature input to a proportional 4-20 mA current output signal. Transmitter shall be a true 2-wire, 4 to 20 mA DC transmitter. Transmitter shall be field programmable from face of unit (without a hand-held programmer or programming software) and shall be configured for ranges shown on Drawings.
 - 1. Power: Requirements: 12 to 42 volt DC.
 - 2. Housing: NEMA 4 unless otherwise noted.
 - 3. Output:
 - a. Two-wire.
 - b. Isolated 4-20 mA.
 - 4. Range Adjustments:
 - a. Zero: 0 to 100 percent non-interacting.
 - b. Span: 0 to 100 percent non-interacting.
 - 5. Accuracy: Plus or minus 0.25 degree F
 - 6. Display:
 - a. Local 4-digit digital display 2/units.
 - b. Local 0 to 100 percent bar graph.
 - c. 7-character alphanumeric display for local programming.
 - 7. Operator Interface: Local keyboard.
 - 8. Environmental: -40 to 167 degrees F.

- B. Transmitter shall have automatic self-diagnostics, automatic self-calibrating, and shall be digitally ambient temperature compensated.
- C. RTD sensor shall be an enclosed connection head type unit pre-wired at factory with three No. 22 silver-plated, standard copper, Teflon-insulated wires. RTD element shall be platinum with a resistance of 100 ohms at 0 degree C, shall be of 0.10 percent precision, and shall conform to IEC 751:1983 Standards.
 - 1. Thermowell Type:
 - a. 3/4-inch NPT threaded well, tapered shank.
 - b. 316 stainless steel.
 - c. Explosion-proof epoxy-coated housing with cap and chain.
 - d. Sealed, moisture-proof, 4-wire element.
 - 2. Wiring: By manufacturer
- D. Sensor length shall be determined by CONTRACTOR to make good thermal contact with a representative portion of room area to ensure accuracy. Refer to installation details for further information on mounting hardware required.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13430 - CONTROL PANELS AND CONSOLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Control panels and consoles.
 2. Switches, push-buttons, lights.
 3. Relays.
 4. Terminal blocks.
 5. Control power transformers.
 6. Transient Voltage Surge Suppression

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Codes, Ordinances, and Industrial Standards: Design, testing, assembly, and methods of installation for materials, electrical equipment, and accessories proposed under this Section shall conform to National Electric Code and to applicable State and local requirements.
 2. UL listing and labeling of custom-built panels (UL 508) shall be adhered to under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Switches, Push-Buttons, Lights:
 - a. Schneider Electric (Square D). (Type K).
 - b. Rockwell Automation (Type 800T/H).
 2. Relays:
 - a. Potter-Brumfield (Type KUP).
 - b. Rockwell Automation (Type 700HB).
 - c. Schneider Electric (Square D). (Type KU).
 - d. Struthers-Dunn (Type 292 Series).
 - e. Omron (Type MK-S)

3. Terminal Blocks; finger safe construction:
 - a. Altech (Type CTS4U-N).
 - b. Rockwell Automation (Type 1492WM4 or Type 1492W4).
 - c. Schneider Electric (Square D). (Type 9080GM6).
 - d. Weidmueller (SAK TS35 or WDU 2.5).
 - e. Phoenix Contact (UT4 Series)
4. Fusible Terminal Blocks:
 - a. Altech (Type CAFL4U).
 - b. Rockwell Automation (Type 1492-CE6H5 or 1492-H6).
 - c. Schneider Electric (Square D). (TeSyS Type DFCC).
 - d. Weidmueller (SAKS1 or ASK1).
 - e. Phoenix Contact (UT4-HESILED24/HESILA250)
5. Control Power Transformers:
 - a. Acme.
 - b. Sola.
6. Transient Voltage Surge Suppression:
 - a. Emerson.
 - b. Sola.
 - c. Schneider Electric (Square D).
7. Textured Polyurethane Enamel:
 - a. Sherwin-Williams, Polane T and/or Polane HST.
8. Wire Markers:
 - a. Brady.
 - b. T&B.
 - c. Westline.

2.02 CONTROL PANELS AND CONSOLES

A. Sheet Metal Construction:

1. Panels and consoles shall be fabricated from sheet steel welded and bolted into a rigid self-supporting structure a maximum of 90 inches high and a minimum of 20 inches deep. Overall length shall be coordinated with space requirements as indicated by Drawings. Changes in length from that shown on Drawings must be brought to attention of ENGINEER within 90 days of Contract Award. Cost to modify floor plan or wall opening shall be at CONTRACTOR's expense after this 90-day period. Panel face layouts shown on Drawings are intended to indicate relative position of all components. Supplier shall fix exact locations and overall dimensions to meet requirements of its equipment.
2. Panel and console bodies shall be 12 gauge minimum steel for panels up to 42 inches in width, and 10 gauge minimum steel for panels exceeding 42 inches in width. Panel subplates shall be same gauge as enclosure. Stiffening members shall be provided for strength and stiffness as required.
3. A minimum of 3 inches shall be provided between edge of panel subplate and outside walls of panel body to ensure adequate wire-way space for external wires entering panel. Panel subplate shall be mounted on collar studs for easy removal. Print pockets shall be provided on each panel. Brackets welded to inside of panel, complete with lights, shall be provided on panels where indicated by Drawings.
4. Identification plates shall be laminated phenolic with black letters engraved on a white background and mounted with screws or double-back adhesive foam tape.
5. All components inside panel shall have identification plates. This includes instruments, relays, switches, circuit boards in plug-in racks, etc. Identification plates shall include engineering

symbols (FBQ-1, SW-3, FIC-4, CR-1, etc.). Switches and circuit breakers inside panel shall have names (Horn, Audio Tone, Panel Power, etc.) on identification plates as well as engineering symbol.

6. Identification plates shall be located on or adjacent to device they are identifying and shall be readable without looking around, under, or on top of device to find identification plate.

B. Access:

1. Wall- and/or floor-mounted control panels shall have continuous piano-hinged doors for ease of access. Door openings shall expose a minimum of 80 percent of panel interior. Door openings shall be sealed with a 0.125-inch thick minimum cellular neoprene gasket cemented with oil-resistant adhesive and held in place with a retaining strip. Print pockets shall be provided on each door. Two door enclosures shall have a removable center post. Panel doors less than 40 inches high shall be equipped with a 2-point latching mechanism. Panel doors 40 inches high or more shall be equipped with a 3-point latching mechanism.
2. Components and terminals shall be accessible without removing another component except covers. Swing out sections shall be used if mounting space is required that is not normally accessible.
3. Panels shall have open bottoms except where structural members are required.

C. Finish:

1. Panel face openings for mounting equipment shall be smoothly finished cut with counterboring and trim strips provided as required to give a neat finished appearance. Bezels shall be used on all front panel-mounted devices to cover panel cutouts. A chrome-plated or stainless steel bezel shall be used at parting line of panels that have shipping splits or at parting line of panels placed end to end.
2. After fabrication, panel surfaces shall be given a phosphatizing treatment inside and out, and then finished with 2 coats of textured polyurethane enamel. Panel interior shall be painted white, ANSI No. 51. Exterior color will be selected by ENGINEER.
3. Panels shall have identical exterior finishes as selected by ENGINEER. Panel finishes on matching colored panels shall be identical. It is supplier's responsibility to achieve this result, especially for panels fabricated in different shops.

D. Electrical:

1. Internal panel wiring shall be 19 strand No. 16 AWG, 90°C MTW, Class C stranded, or THHN/THWN approved as 90°C MTW. All panel wiring not run in wire ducts shall be bundled and tied. Each wire shall be identified at both ends with same exclusive number. Number shall be same number shown on control schematic. Number shall not be used again for any other purpose. Wires marked differently on each end will not be accepted. Wire markers shall be provided on end of each wire at termination point.
2. Control wiring associated with control circuits de-energized when main disconnect is opened shall be color-coded red. Control wiring associated with control circuits which remains "hot" when main disconnect is opened shall be color-coded yellow. DC control wiring shall be color-coded blue. Ground wires shall be color-coded green. Terminal blocks shall be numbered in numerical order. Yellow wiring leaving panel shall be brought to an isolated set of terminal blocks.
3. Provide an instrument common bus 0.1 by 0.5 by 6-inch minimum in enclosure and isolated from enclosure. A separate instrument common wire shall be run from each common terminal on an instrument to instrument common bus. Instrument common wires looped from one terminal to another and then to instrument common bus will not be accepted.

4. Instrument common bus shall be connected to power supply common with a wire or wire braid strap as short as practical and of sufficient capacity to prevent troublesome voltage drop. Common terminals and common bus for instrument common shall be tagged "Instrument Common." Instrument signal wires of 4-20 mA or 1-5V shall be shielded wire. Telephone wires and telemetry equipment interconnection wires shall be shielded wires.
5. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosure are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
6. Wires to internal components shall be connected to inside of terminal strip. Wires to external components shall be connected to outside of terminal strip. No more than 2 wires shall be connected to one terminal point.
7. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of 1-inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of nonmetallic materials with a voltage insulation in excess of maximum voltage carried therein.
8. Floor-standing panels and consoles shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Single phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
9. Disconnect and transformer shall have enclosed protected terminations to prevent accidental shock.
10. Within each control panel a Transient Voltage Surge Suppression (TVSS) device shall be installed at the main disconnect and shall be sized for the control panel feeder size.
11. Relays, timers, etc., installed on panel subplate shall be provided with a minimum spacing between component and wire duct of 1.5 inches above and 1 inch below. Minimum spacing between adjacent components shall be 0.25 inch. Relays, timers, etc., shown in schematics are intended to show function. Additional relays may be required in conjunction with items shown to provide total number of contacts required. Where limit, pressure, float switches, etc., are used and more than SPDT contacts are indicated by schematics, provide additional contacts required by using auxiliary relays. However, if a DPDT switch is called for, using a SPDT with a relay will not be accepted. All control and pilot devices such as relays, timers, etc., shall be 120V, 3 amp rated except where noted with coil voltage as required. One N.O. spare contact shall be provided on each relay.

E. Panel/Subplate Layout:

1. Panel face-mounted equipment shall consist of pilot lights, push-buttons, selector switches, meters, indicating timer, etc. Spacing between horizontal rows of components shall be 1.5 inches minimum; spacing between vertical columns of components shall be 1.875 inches minimum. Components shall be grouped and/or located as indicated on Drawings. Distance from bottom row of components to floor shall be not less than 36 inches. Top row of recording and indicating instruments shall be centered approximately 60 inches above floor. Maximum height for annunciator windows shall be 85 inches above floor. In general, indicating lights, push-buttons, etc., shall be mounted in accordance with sequence of operation from left to right and top to bottom.
2. A minimum of 2 inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on vertical edges of

subplate. Where terminal strips are mounted side-by-side, terminals shall be elevated 1.5 inches above subplate to allow wires to pass underneath.

3. Subplates shall have a minimum of 15 percent spare mounting space, and terminal strips shall have a minimum of 20 percent spare terminal blocks.

2.03 SWITCH, PUSH BUTTONS, LIGHTS

- A. Selector switches shall be 120 VAC rated, oil-tight construction with standard operator knob.
- B. Start push buttons shall be 120 VAC rated, oil-tight construction with extended guard and black color insert.
- C. Stop push-buttons shall have a half-guard with red color insert. Contacts shall be rated NEMA B-150 and P-150.
- D. Pilot lights shall be push-to-test oil-tight construction with cap colors and voltages as required. Pilot light shall be supplied with Light Emitting Diode (LED) type light module.
- E. Nameplates for each switch and light shall conform to manufacturer's series and type with engraving as called for on Drawings.

2.04 RELAYS

- A. Control Relays: Switching and output relays shall be plug-in type with contacts rated 120 VAC, 3 amp with 120 VAC or 24 VDC coil, indicating light, manual operator, and plastic transparent cover. Relays shall have a retainer mechanism to prevent loosening from vibration. Relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.

2.05 TERMINAL BLOCKS

- A. Terminal blocks shall be 300 or 600 volt rated, channel-mounted box lug with pressure plate type or binding head screw type with pressure plate, and shall have a white marking strip. Terminal blocks shall be color-coded according to the following coloring scheme:

Black	120V power circuits de-energized when main disconnect is opened.
White	120V neutral conductors.
Red	120V control circuits de-energized when main disconnect is opened.
Yellow	120V control circuits which remain hot when main disconnect is opened.
Blue	Terminal blocks for DC wiring.
Gray	Terminal blocks for shields in DC wiring.
Green	Ground terminal blocks.
- B. For terminals associated with 120V nonisolated input cards, individually fused terminal blocks shall be used for 120V power to field devices.
- C. Provide a minimum of 20 percent spare terminals for each type and color of terminal used. All terminals of a given color shall be grouped with other terminals of the same color.

2.06 CONTROL POWER TRANSFORMERS

- A. Control power transformers shall be sized to handle in-rush currents and to accommodate continuous load of circuits plus 25 percent future load with 5 percent or less voltage drop. Transformer primary voltage shall be as indicated on Drawings.

2.07 Transient Voltage Surge Suppression (TVSS)

- A. Transient Voltage Surge Suppression (TVSS) device shall be installed at the main disconnect. TVSS shall be sized for the control panel feeder size and shall protect equipment from a peak surge of 45kA per mode and minimum 80kA peak surge per phase. Protection modes shall include phase to phase, and phase to ground for three phase panels, and shall include phase to neutral, phase to ground and neutral to ground for single phase panels. TVSS shall have a status LED indicating that it is operating properly.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13441 - INDICATORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Digital indicator.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Digital Indicator:
 - a. Precision Digital.
 - b. Red Lion
 - c. Yokogawa.

2.02 DIGITAL INDICATOR

- A. Digital indicators shall be of the digital process monitor type with a 3.5-digit direct reading display receiving 4-20 mA DC input signal. This assembly shall have an overall accuracy of 1 percent or better. Decimal point placement shall be field adjustable to any digit. Reading refresh rate shall be greater than one second.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

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SECTION 13491 – INSTRUMENTATION SPARE PARTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Instrumentation system spare parts.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Spare Parts List: Submit a list of recommended spare parts for the equipment provided as part of the instrumentation system.

1.03 DELIVERY

- A. Deliver spare parts to OWNER prior to final acceptance of instrumentation system and equipment.

PART 2 - PRODUCTS

2.01 SPARE PARTS

- A. Equipment spare parts as required for 1 year shall be provided and stored at Site by CONTRACTOR.
- B. Spares consumed during construction shall be replaced at no cost to OWNER until equipment is accepted as defined in Specification.
- C. Provide the following:
 - 1. One spare relay of each type used, including time-delay relays.
 - 2. One-year supply of expendable spares such as lamps, fuses, ink, ribbons, etc.
- D. Digital Systems: For digital systems, spare parts as required for a period of 1 year shall be provided and stored at Site, unless directed otherwise by OWNER.
- E. Provide the following:
 - 1. On systems employing PLCs, provide 1 spare circuit card of each type used in delivered equipment. Circuit cards shall include the following (matching units in service):
 - a. Analog input card.
 - b. Analog output card.
 - c. Discrete input card.
 - d. Discrete output card.
 - 2. Provide 1 spare module of each type listed below:
 - a. PLC processor of type used in delivered equipment.
 - b. Communication card of type used in delivered equipment.
 - c. Rack power supply

3. Provide a box of fuses for each size and type used.
4. Provide one spare 24 VDC power supply

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 15050 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
 - 1. Submittals.
 - 2. Record documents.
 - 3. Maintenance manuals.
 - 4. Quality assurance.
 - 5. Delivery storage and handling.
 - 6. Guarantee.
 - 7. Rough-ins.
 - 8. Mechanical installations.
 - 9. Cutting and patching.

- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, piping/ductwork transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. CONTRACTOR shall fully coordinate mechanical work with other trades to avoid interferences.
 - 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. A schedule indicating the system, line size, line material, joints, fittings, valves, insulation thickness, hanger type and spacing, test pressure and shop finish for each system shown on the Drawings and/or specified herein.
 - 2. Complete layout drawings of all pipe sleeves, ductwork, etc., showing all sizes and controlling elevations.
 - 3. No work shall be undertaken until such drawings, specifications and schedules have been approved by ENGINEER. Approval of this data by ENGINEER shall not relieve CONTRACTOR of responsibility for the completeness, coordination, and dependable operation of the system as installed.

- B. Product Data: Submit in accordance with requirements of Section 01330, product data covering the items included under this Division of the Work.

- C. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.

- D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01781, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Permits, Inspections and Licenses: CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory or political subdivision thereof, wherein the Work is done, or any other duly constituted public authority.
 - 1. Upon completion of the Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit three copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses and certifications when such fees are required.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.05 PROJECT CONDITIONS

- A. Painting and Identification: Painting of piping and drainage lines installed as a part of this Work will be done under Section 09900, Painting.
 - 1. CONTRACTOR under this Section shall identify and label lines clearly so painting contractor can apply correct color(s) to each pipe.
 - 2. CONTRACTOR under this Section shall apply pipe labels to the pipe after painting has been completed. The piping labels shall include the pipe material and flow direction.
- B. Motors: Motors shall comply with the specifications as set forth in Section 16220. Submit motor manufacturer's name with Shop Drawings for approval.
 - 1. All motors in Division 15 shall be TEFC Premium Efficiency unless noted otherwise in the specific Division 15 Sections or on mechanical drawing Schedules.
- C. Stainless Steel: All stainless steel referenced in the specifications is 316 Stainless Steel unless otherwise noted herein or on the drawings.

PART 2 – PRODUCTS

2.01 PIPE LABELS

- A. Provide Vinyl pipe label that attach to the pipe with tie-wraps or formed label that snaps on the pipe. Labels shall be rated for indoor and outdoor use.
 - 1. Label Manufactures Seton Name Plate Corporation, W.H. Brady, James H. Matthews, or approved equal.
- B. Labels that use adhesive shall not be used.
- C. Where product labels are not available for the media in the pipe, the contractor may paint the background the stencil the pipe product and flow arrow on the pipe.

PART 3 - EXECUTION

3.01 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

3.02 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements.
 - 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - 4. 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. Furnish, set, and grout or secure in place all required sleeves.
 - 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 1. Unless noted otherwise on Drawings, mount unit heaters 8'-0" above finished floor.
- C. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- D. Install systems, materials, and equipment to conform with approved submittal data. Conform to arrangements indicated by the Contract Documents, recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- E. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- F. Install mechanical 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. Extend grease fittings to an accessible location.
- G. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Section 08110.
- H. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.03 PIPE AND EQUIPMENT IDENTIFICATION:

- A. Label all piping showing contents and direction of flow.
- B. Place label adjacent to each valve and branch takeoff, at each side of a wall or partition through which pipe passes; and at 20 feet 0 inch spacing on straight runs.
- C. C. Label Manufacturers: Seton Name Plate Corporation, W.H. Brady, Topflight Tape Company, James H. Matthews, or approved equal.
- D. Paint or stencil 1-1/2 inch high black enamel block type letters or numerals on all equipment items

3.04 VALVE IDENTIFICATION:

- A. A. Brass Tags: 1-inch diameter, secured to each valve with brass S-hook and stamped with system designation and assigned number.
- B. Obtain existing valve schedule from Owner and review existing valve naming sequence. Submit proposed schedule showing proposed continuation of sequence to Architect / Engineer for approval. Provide a printed schedule, in duplicate, describing each valve by number, giving location and service for which used.

3.05 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with the following requirements:
 - 1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Install equipment and materials in existing structures.
- C. Upon written instructions from ENGINEER, uncover and restore Work to provide for ENGINEER observation of concealed Work.
- D. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- E. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- F. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

- G. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.
- H. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

END OF SECTION

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SECTION 15058 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. 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.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.

- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Bearings shall be rated at 80,000 hrs. at an L10 rating system.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. 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. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. 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.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. 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.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.

- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: 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.

PART 3 - EXECUTION

NOT USED

END OF SECTION

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SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 1. Metal pipe hangers and supports.
 2. Metal framing systems.
 3. Fastener systems.

1.03 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to:
 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.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details; include Product Data for components:
 1. Metal framing systems.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Stainless-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 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. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with inturred lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.03 THERMAL-HANGER SHIELD INSERTS

- 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. Carpenter & Paterson, Inc.
 - 2. Clement Support Services.
 - 3. ERICO International Corporation.
 - 4. National Pipe Hanger Corporation.
 - 5. PHS Industries, Inc.
 - 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 7. Piping Technology & Products, Inc.
 - 8. Rilco Manufacturing Co., Inc.
 - 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal 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 the building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- C. 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.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. 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.

- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. 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 (DN 65) and larger and at changes in direction of piping. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. 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.

3.02 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

3.03 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 (40 mm).

3.04 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 a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09900 "Painting."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.05 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are 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 stainless-steel pipe hangers and attachments for general service applications.
- F. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. (DN 10 to DN 80).
 - 3. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
- I. 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 (DN 24 to DN 600).
 - 2. Stainless Steel-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Stainless Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
- K. 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-joist 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. C-Clamps (MSS Type 23): For structural shapes.
 - 5. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
- L. 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.

- M. Comply with MFMA-103 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.

END OF SECTION

SECTION 15062 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Metal framing systems.
 - 3. Equipment supports.
- B. Related Sections:
 - 1. Section 15815 "Metal Ducts" for duct hangers and supports.

1.03 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC 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.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Metal framing systems.
 - 2. Equipment supports.

1.06 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.02 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 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. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with inturned lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.03 THERMAL-HANGER SHIELD INSERTS

- 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. Carpenter & Paterson, Inc.
 - 2. Clement Support Services.

3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.06 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal 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 the building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- C. 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.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. 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.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. 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 (DN 65) 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.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. 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.
- K. Insulated Piping:
 - 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 allowed by 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 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 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.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for 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.

3.04 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 (40 mm).

3.05 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 a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09900 "Painting"
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are 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 nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use stainless-steel pipe hangers and stainless-steel attachments for general service applications.
- E. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
- I. 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 (DN 24 to DN 600).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- J. 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 (150 mm) for heavy loads.
 2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- K. 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-joist 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.
- 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-103 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.

END OF SECTION

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SECTION 15076 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.03 ACTION 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.

1.04 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

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch (0.8-mm), Stainless steel, 0.025-inch (0.64-mm), Aluminum, 0.032-inch (0.8-mm), or anodized aluminum, 0.032-inch (0.8-mm) 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 (64 by 19 mm).

3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), 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. Label Content: Include equipment's Drawing designation or unique equipment number..

2.02 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) 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 (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), 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 rivets or 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.

2.03 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. 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 (38 mm) high and larger as the pipe size increases.

2.04 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) 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.

2.05 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass, 0.032-inch (0.8-mm), Stainless steel, 0.025-inch (0.64-mm), Aluminum, 0.032-inch (0.8-mm), or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.

2.06 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
- B. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
 - 1. Fasteners: Reinforced grommet and wire or string.
 - 2. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 3. Color: Yellow background with black lettering.

2.07 LIFTING LUGS

- C. Lifting Lugs: Provide tags indicating the maximum allowable load capacity of the lifting lugs provided in the ceiling.

PART 3 - EXECUTION

3.01 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 encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

- C. Label existing piping systems and within the pump house including:
 - 1. Well Pump discharge pipe: WELL WATER
 - 2. Well Pump: P-XXX, where XXX represents pump building number.
 - 3. Well Pump isolation Valves: GV-XXX (gate valve) and CK-XXX (check valve)

3.03 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Section 09900 "Painting." Label color shall match pipe color.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, 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 20 feet (15 m) along each run. Reduce intervals (7.6 m) in areas of congested piping and equipment to distinguish different piping systems.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Pipe Label Color Schedule:
 - 1. Refer to Section 09900 "Painting" for pipe label colors.

3.04 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, 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. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - 3. Letter Color:
 - a. Cold Water: Black.
- C. Install tags for existing pumps.

3.05 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.06 WEIGHT AND CAPACITY IDENTIFICATION

- A. Stencil the weight of the equipment or apply a manufactured tag that is legible for the floor to indicate that weight of the equipment. Weight of the equipment shall be coordinated with actual installed equipment or as identified by the equipment supplier, manufacturer, or standard literature for the equipment installed. Items to have weight tag include but not limited to:
 - 1. Pump Motor
 - 2. Pump (Without Motor)
 - 3. Valves, pipe fittings, and piping sections 6" diameter and larger.
 - 4. Mechanical equipment that is mounted from the structural steel or building system.
 - 5. Roof Top Gravity Ventilators. Capacity shall be legible for the interior of the building.
 - 6. Generators, including the weight of the exhaust silencer.
 - 7. Floor mounted electrical equipment including VFDs, Transformers, Motor Controls Centers, and Switch Gear.
- B. Lifting Lug Capacity: Coordinate installation of capacity rating of the lift lug and lifting anchor with Building Supplier and approved shop drawings. The lifting capacity of the lug or anchor shall be clearly visible from the floor.

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SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 1. Equipment labels.
 2. Warning signs and labels.
 3. Stencils.
 4. Warning tags.

1.03 ACTION SUBMITTALS

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

1.04 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

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 1. Material and Thickness: Brass, 0.032-inch (0.8-mm), Stainless steel, 0.025-inch (0.64-mm) Aluminum, 0.032-inch (0.8-mm) anodized aluminum, 0.032-inch (0.8-mm) 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 (64 by 19 mm).
 3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), 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.

6. Plastic Labels for Equipment:
 7. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
 8. Letter Color: White.
 9. Background Color: Black.
 10. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 11. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 12. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 13. Fasteners: Stainless-steel rivets or self-tapping screws.
 14. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), 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 rivets or 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.

2.03 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) 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.

2.04 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 (75 by 133 mm) 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

3.01 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 encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.03 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

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SECTION 15085 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Domestic Water Piping with respect to this project includes the Well Water from the well pump.
- B. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Well water piping

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.04 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing 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 agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.05 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.

1.06 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 15061 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping 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.

1.07 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

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.02 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 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. Aeroflex USA, Inc.; Aero seal.

- b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive 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. PVC Jacket Adhesive: Compatible with PVC jacket.
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. Dow Corning Corporation; 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; Polyco VP Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive 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."

2.03 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass and Phenolic Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

- B. PVC Jacket Flashing Sealants:
 - 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: White.
 - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 7. Sealants 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."

2.04 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 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. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: Color-code jackets based on system.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 5. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 6. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.08 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.

3.09 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water and Well Water:
1. NPS 1 (DN 25) and Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 2. NPS 1-1/2" > and Larger: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.

3.10 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. Piping, Domestic Cold Water and Well Water:
1. PVC, Color-Coded by System: 30 mils thick.

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SECTION 15086 - DUCT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, exposed supply and outdoor air.
 - 2. Indoor, Engine Exhaust.
- B. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
Related Sections:
 - 1. Section 15088 "HVAC Piping Insulation."

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.04 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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 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.

1.05 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.

1.06 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 15062 "Hangers and Supports for HVAC Piping and Equipment."

- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork 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.

1.07 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

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 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. CertainTeed Corp.; Commercial Board.
 - b. Fibrex Insulations Inc.; FBX.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Insulation Board.
 - e. Manson Insulation Inc.; AK Board.
 - f. Owens Corning; Fiberglas 700 Series.

- G. Engine Exhaust Insulation:
1. Provide custom designed flexible removable insulation blanket
 - a. Temperature Range: 20 degree F to 1100 degree F.
 - b. Thickness: 1 inch
 - c. Density: 9 lbs per cubic foot
 - d. Material: Insulation composed of 100% Type "E: fibers with 20 ounce vermiculite thermal cloth on the inner jacket and 17 ounce blue Teflon coated thermal cloth on the outer jacket.
 - e. Construction: 10-ply 304 stainless steel thread
 - f. Attachment: High temperature Velcro strips and belts with stainless steel double d-rings.
 - g. Thermal Conductivity: 0.50 Kbtu*inch /sqft/hr/degree F at 500 F mean temperature.
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. GT Exhaust
 - b. Or Equal

2.02 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-03/11-70.Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive 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. ASJ Adhesive, and FSK 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, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive 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. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 5. Color: White.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants 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."

2.03 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.04 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
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. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches (75 mm).
 3. Thickness: 11.5 mils (0.29 mm).
 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.05 SECUREMENTS

- A. Bands:
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. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal.

3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.06 CORNER ANGLES

- A. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- J. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-

applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.05 ENGINE EXHUAST SYSTEM INSULATION INSTALLATION

- A. Install the insulation per the manufacturer's recommendations. The insulation shall be fabricated to the size of the component insulated.
- B. Insulate the following engine exhaust components:
 1. Flexible connectors and piping between the engine exhaust discharge and silencer
 2. Engine silencer
 3. Engine exhaust piping and connector from the engine silencer to the exterior wall.

3.06 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, exposed supply and outdoor air.
 2. Indoor, Engine exhaust.
 3. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- B. Items Not Insulated:
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Flexible connectors.
 4. Vibration-control devices.
 5. Factory-insulated access panels and doors.

3.07 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Exposed, rectangular, supply-air duct insulation shall be the following:
 1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- B. Exposed, rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- C. Exposed, rectangular, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- D. Exposed, rectangular, exhaust-air duct insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- E. Exposed, Engine Silencer and Engine Exhaust the following:
1. Engine Exhaust Insulation: 1 inch thick, 9 lbs/ cu. Ft.

END OF SECTION

SECTION 15088 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Refrigerant suction and hot-gas piping, indoors.
- B. Related Sections:
 - 1. Section 15086 "Duct Insulation."

1.02 ACTION SUBMITTALS

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

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to 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 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.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 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. Aeroflex USA, Inc.; Aerocel.
- b. Armacell LLC; AP Armaflex.
- c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.02 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 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. Aeroflex USA, Inc.; Aero seal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive 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."

2.03 SEALANTS

- A. Joint Sealants:
 1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
 5. Color: White or gray.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants 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."

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches (50 mm)] [4 inches (100 mm)] o.c.
 - 4. For below-ambient services, apply vapor-barrier mastic over staples.
 - 5. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.03 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):
Install insulation continuously through walls and partitions.

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 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.

3.07 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric, 1 inch (25 mm) thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1 inch (25 mm) thick.

END OF SECTION

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SECTION 15092 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 SLEEVES

- A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.02 STACK-SLEEVE FITTINGS

- 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. [Smith, Jay R. Mfg. Co.](#)
 - 2. [Zurn Specification Drainage Operation; Zurn Plumbing Products Group.](#)
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

- 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. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping 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.

2.04 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.05 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [1-inch (25-mm)] <Insert dimension> annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

2. 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.
 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07920 "Joint Sealants."

3.02 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07620 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.

3.03 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.05 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves Insert material.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Interior Partitions:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
 - b. Piping [NPS 6 (DN 150)] and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 15111 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
- B. Related Sections:
 - 1. Section 02510 "Water Distribution" for valves applicable only to this piping.

1.03 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.
- B. Certification: Provide certification for Lead Free Compliance with NSF/ANSI 372

1.05 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

- C. NSF Compliance:
 - 1. NSF 61 for valve materials for potable-water service.
 - 2. NSF/ANSI 372 for LEAD FREE product materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.
- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

- H. Lead Free Compliance: All valves installed in potable water applications or connected to the primary source for the production of potable water shall be lead free.
1. Components shall be 3rd party certified per NSF/ANSI 372
 2. Lead Free: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with CA AB1953, VT Act 193, MD HB372, LA HB471 and Federal Public Law 111-380. ANSI 3rd party approved and listed.

2.02 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
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. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Lance Valves; a division of Advanced Thermal Systems, Inc.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, with stainless-steel trim.

END OF SECTION

SECTION 15126 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Dial-type pressure gages.
 - 2. Gage attachments.
- B. Related Sections:
 - 1. Section 15140 "Domestic Water Piping" for water meters inside the building.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification: Provide certification for Lead Free Compliance with NSF/ANSI 372 Material Section

1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 MATERIALS – GENERAL:

- A. Lead Free Compliance: All valves installed in potable water applications or connected to the primary source for the production of potable water shall be lead free.
 - 1. Components shall be 3rd party certified per NSF/ANSI 372.
 - 2. Lead Free: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with CA AB1953, VT Act 193, MD HB372, LA HB471 and Federal Public Law 111-380. ANSI 3rd party approved and listed.

2.02 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 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. Ashcroft Inc.
 - b. Terice, H. O. Co.
 - 2. Standard: ASME B40.100.
 - 3. Case: Stainless steel; 4-1/2-inch (114-mm) nominal diameter.
 - 4. Wetted Materials: 316 Stainless Steel.
 - 5. Pressure-Element Assembly: Lead Free Bourdon tube unless otherwise indicated.
 - 6. Pressure Connection: Stainless Steel, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 7. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 8. Dial: White background and Black markings graduated in psi and kPa.
 - 9. Pointer: Dark-colored metal.
 - 10. Window: Glass or plastic.
 - 11. Ring: Metal.
 - 12. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
 - 13. Range: 0-200 PSI unless otherwise noted.
 - 14. Liquid filled; compatible with drinking water NSF and AWWA approved.

2.03 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- B. Install valve and snubber in piping for each pressure gage for fluids.
- C. Install pressure gages in the following locations:
 - 1. Suction and discharge of each domestic water pump.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be the following:
 - 1. Liquid-filled, direct-mounted, metal case.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 160 psi and 0 to 1100 kPa.

END OF SECTION

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SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
 - 2. Encasement for piping.
- B. Related Requirements:
 - 1. Section 02510 "Water Distribution" for water service piping outside the source to point where water service piping enters the building.

1.03 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.
- B. Certification: Provide certification for Lead Free Compliance with NSF/ANSI 372 Material Section.

1.04 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.05 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."
- C. Components shall be Lead Free per NSF/ANSI 372
 - 1. The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with CA AB1953, VT Act 193, MD HB372, LA HB471 and Federal Public Law 111-380. ANSI 3rd party approved and listed.

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSSSP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.

2.03 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe:
 - 1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.
 - 2. Include ends matching joining method.
- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
- C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable-Iron Unions:
 - 1. ASME B16.39, Class 150.
 - 2. Hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal, bronze seating surface.
 - 4. Threaded ends.

2.04 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International.
 - e. Matco-Norca.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C) 300 psig (2070 kPa) Insert value.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Nipples:

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. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

2.05 HOSE:

A. Hoses:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Uniroyal.
 - b. BF Goodrich.
 - c. Grainger (Part # 8Z674)
 - d. SWAN.
 - e. Westward.
2. General: Heavy Duty Industrial Garden Hose. Hose shall be dual reinforced to prevent kinks with crush proof connections. Hose shall be abrasion resistant.
3. Nominal Hose Diameter: 3/4".
4. Hose Material: Reinforced Rubber
5. Connection: Garden Hose Thread
6. Color: Red
7. Pressure Rating: 400 psig (860 kPa) minimum at 120 deg F (82 deg C).
8. Length: Maximum section length 50'. Where length over 50' is noted here-in or on drawings, provide multiple lengths of 50' to achieve length.
9. Listing: NSF 61

B. Accessories:

1. Provide Wall mount Stainless Steel hanger with a minimum hose capacity of 100' for 5/8" hose. GRAINGER Part # 21AC25 or equal
2. Provide adjust hose nozzle with shutoff valve. Nozzle shall be High-Flow Fire Hose Spray Tip with adjustable spray/Shutoff Handle. GRAINGER Part # 2LPN3 or equal.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Comply with requirements in Section 02300 "Earthwork" for excavating, trenching, and backfilling.

3.02 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. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

- D. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- 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 for pressure gages in Section 15126 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 15145 "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. 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.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- N. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 15126 "Meters and Gages for Plumbing Piping."
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15092 "Sleeves and Sleeve Seals for Plumbing Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15092 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15097 "Escutcheons for Plumbing Piping."

3.03 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 for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: 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. 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.

3.04 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric nipples.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 15061 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
- E. Install supports for vertical copper tubing every 10 feet (3 m).

- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
 - 4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
 - 5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
 - 6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
 - 7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
 - 8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
- G. Install supports for vertical steel piping every 15 feet (4.5 m).

3.06 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3.07 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 15076 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.08 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. 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:
 - 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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. 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.
 - c. 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.
 - d. Cap and subject piping to static water pressure of 50 psig (345 kPa) 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.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.09 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 hot-water flow 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.

3.10 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 (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow 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. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- 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. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller < shall be the following:
 1. Soft copper tube, ASTM B 88, Type K wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints. This is only allowed on the Air/Vacuum relief valve discharge piping.
 2. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints. This may also be used on the Air/Vacuum relief valve discharge piping

- F. Underground domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K; cast- or wrought-copper, solder-joint fittings; and flared joints.

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 (DN 50) and smaller
 - 2. Drain Duty: Hose-end drain valves.

END OF SECTION

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Domestic Water Piping with respect to this project includes the Well Water from the well pump.
- B. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Hose bibbs.
 - 4. Drain valves.
 - 5. Combination Air and Vacuum Air Relief Valve (ARV).
- C. Related Requirements:
 - 1. Section 15126 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Certification: Provide certification for Lead Free Compliance with NSF/ANSI 372 Material Section.
- C. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14.
- B. Products and be LEAD FREE in compliance with NSF/ANSI 372. The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with CA AB1953, VT Act 193, MD HB372, LA HB471 and Federal Public Law 111-380. ANSI 3rd party approved and listed.

2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 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. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; a division of Watts Water Technologies, Inc.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Arrowhead Brass Products.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Woodford Manufacturing Company; a division of WCM Industries, Inc.

- i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
- j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- 2. Standard: ASSE 1011.
- 3. Body: Bronze, nonremovable, with manual drain.
- 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- 5. Finish: Rough bronze.

2.04 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

- 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. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; a division of Watts Water Technologies, Inc.
 - d. Flomatic Corporation.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- 2. Standard: ASSE 1013.
- 3. Operation: Continuous-pressure applications.
- 4. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
- 5. Size: 3/4 NPS.
- 6. Design Flow Rate: 12 GPM.
- 7. Pressure Loss at Design Flow Rate: 12 PSIG for sizes NPS 2 (DN 50) and smaller.
- 8. Body: Bronze for NPS 2 (DN 50) and smaller.
- 9. End Connections: Threaded for NPS 2 (DN 50) and smaller
- 10. Configuration: Designed for horizontal, straight-through flow.
- 11. Accessories:
 - a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.05 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

- 1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
- 2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
- 3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
- 4. Screen: Stainless steel with round perforations unless otherwise indicated.
- 5. Perforation Size:
- 6. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
- 7. Drain: Pipe plug.

2.06 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 (DN 15 or DN 20) threaded or solder-joint inlet.
 - 5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 - 6. Pressure Rating: 125 psig (860 kPa).
 - 7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 - 8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.

2.07 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 (2760-kPa) minimum CWP.
 - 3. Size: NPS 3/4 (DN 20).
 - 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.

2.08 COMBINATION AIR AND VACUUM RELEASE VALVES (ARV):

- A. Air valves for submerged pumps shall be designed to allow large quantities of air to escape out the orifice when the pump is started and close watertight when the liquid enters the valve. The air valve shall also permit large quantities of air to re-enter through the orifice when the pump is stopped to prevent a vacuum from forming in the pump column.
- B. The valve shall consist of a body, cover, baffle, float, and seat. The baffle will be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, without distortion, and shall be easily removed, if necessary.
- C. The entire float and baffle assembly must be shrouded with a perforated water diffuser to prevent the water column entering the valve, from slamming the float shut and eliminate water hammer in the system.
- D. The discharge orifice shall be fitted with an adjustable throttling device to regulate the flow of air escaping to establish a pressure loading on the rising column of water to minimize shock to the pump and check valve.

- E. The float shall be stainless steel, designed to withstand a minimum of 1,000 psi. The float shall be center-guided and not free floating for positive seating. The valve body shall be cast iron, ASTM A 48.

PART 3 - EXECUTION

3.01 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 unacceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- B. Install Y-pattern strainers for water on supply side of each backflow preventer.
- C. Install air vents at high points of water piping where shown.

3.02 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Reduced-pressure-principle backflow preventers.
- 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 Section 15076 "Identification for Plumbing Piping and Equipment."

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.04 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

SECTION 15150 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.03 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 (30 kPa).
 - 2. Waste, Force-Main Piping: 50 psig (345 kPa).

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L and Type M (ASTM B 88M, Type B and Type C), water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
- E. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.03 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- C. Solvent Cement: ASTM D 2235.
 - 1. ABS solvent cement shall have a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement 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."

2.04 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive primer 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. Solvent Cement: ASTM D 2564.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Solvent cement 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."

2.05 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 3. Unshielded, Nonpressure Transition Couplings:
 - 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) [Dallas Specialty & Mfg. Co.](#)
 - 2) [Fernco Inc.](#)
 - 3) [Mission Rubber Company; a division of MCP Industries, Inc.](#)
 - 4) [Plastic Oddities; a division of Diverse Corporate Technologies, Inc.](#)
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. 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.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- C. 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.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. 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 two 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.
- K. 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.
- L. 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 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- N. Install aboveground ABS piping according to ASTM D 2661.
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground ABS and PVC piping according to ASTM D 2321.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15092 "Sleeves and Sleeve Seals for Plumbing Piping."

- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15092 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15097 "Escutcheons for Plumbing Piping."

3.02 JOINT CONSTRUCTION

- A. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- B. Plastic, Nonpressure-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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.03 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Unshielded, nonpressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 15073 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 15061 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 4. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 5. Install individual, straight, horizontal piping runs:
 - 6. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
 5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
 6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- F. Install supports for vertical copper tubing every 10 feet (3 m).
- G. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
 2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
 3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
 4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
 5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
- H. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.05 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. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. 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 (DN 65) and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

- E. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.06 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 15076 "Identification for Plumbing Piping and Equipment."

3.07 CLEANING AND PROTECTION

- 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.
- D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.08 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
 - 1. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 2. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
 - 1. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION

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SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Channel drainage systems.
 - 2. Miscellaneous sanitary drainage piping specialties.
 - 3. Solids interceptors.
- B. Related Requirements:

1.03 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.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Trench Drains.
 - 2. Sump Basin.

1.05 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 CHANNEL DRAINAGE SYSTEMS

A. Plastic Channel Drainage Systems :

1. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - a. Channel Sections: Interlocking-joint, HDPE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - 1) Dimensions: 6 inches wide. Include number of units required to form total lengths indicated.
 - b. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
 - 1) Material: Galvanized Ductile Iron Bar Grate – Class C.
 - c. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 - d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.02 SOLIDS INTERCEPTORS

A. Solids Interceptors

1. Plastic Solids Interceptors:
 - 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) Ashland Trap Distribution Co.
 - 2) Schier Products Company.
 - 3) Town & Country Plastics, Inc.
2. Type: Factory-fabricated interceptor made for temporary storage of wastewater.
3. Body Material: Plastic.
4. Interior Lining: Not required.
5. Exterior Coating: Not required.
6. Body Dimensions: See Equipment Schedule
7. Flow Rate: Not required.
8. Inlet Size: 3".
9. End Connections: Pipe Stub, See plans for inlet stub elevation.
10. Mounting: In Floor.
11. Cover: Solid galvanized cover plates with sealed penetrations for vent pipe, sump pump discharge, and electrical.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

- B. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

3.02 CONNECTIONS

- A. Comply with requirements in Section 15150 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.03 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

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SECTION 15195 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 1. Pipes, tubes, and fittings.
 2. Piping specialties.
 3. Piping and tubing joining materials.
 4. Valves.
 5. Pressure regulators.
 6. Service meters.
 7. Concrete bases.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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.

1.04 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
 2. Service Regulators: 100 psig (690 kPa) minimum unless otherwise indicated.
 3. Minimum Operating Pressure of Service Meter: 5 psig (34.5 kPa).
- B. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 1. Piping specialties.
 2. Corrugated, stainless-steel tubing with associated components.
 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 4. Pressure regulators. Indicate pressure ratings and capacities.

5. Service meters. Indicate pressure ratings and capacities. Include meter bars supports.
6. Dielectric fittings.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.08 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. 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.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.10 PROJECT CONDITIONS

- E. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- F. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.11 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 08311 "Access Doors and Frames."

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 - 6. Mechanical Couplings:
 - 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) [Dresser Piping Specialties; Division of Dresser, Inc.](#)
 - 2) [Smith-Blair, Inc.](#)
 - b. Stainless-steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
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. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation; Parflex Division.
 - c. Titeflex.
 - d. Tru-Flex Metal Hose Corp.
 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 3. Coating: PE with flame retardant.
 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 5. Striker Plates: Steel, designed to protect tubing from penetrations.
 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 7. Operating-Pressure Rating: 5 psig (34.5 kPa).
- C. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.

- e. Tracer wire connection.
- f. Ultraviolet shield.
- g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 5. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Capable of joining PE pipe to PE pipe.
 - 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) [Lyll, R. W. & Company, Inc.](#)
 - 2) [Mueller Co.; Gas Products Div.](#)
 - 3) [Perfection Corporation; a subsidiary of American Meter Company.](#)
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.
- 6. Plastic Mechanical Couplings, NPS 2 (DN 50) and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - 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) [Lyll, R. W. & Company, Inc.](#)
 - 2) [Mueller Co.; Gas Products Div.](#)
 - 3) [Perfection Corporation; a subsidiary of American Meter Company.](#)
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.
 - d. Buna-nitrile seals.
 - e. Acetal collets.
 - f. Stainless-steel bolts, nuts, and washers.
- 7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - 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) [Dresser Piping Specialties; Division of Dresser, Inc.](#)
 - 2) [Smith-Blair, Inc.](#)
 - b. Stainless-steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Factory-installed anode for steel-body couplings installed underground.

2.02 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 72 inches (1830 mm.)

- B. Y-Pattern Strainers:
 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
 3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 125 psig (862 kPa).
- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.03 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.04 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 1. CWP Rating: 125 psig (862 kPa).
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
 1. CWP Rating: 125 psig (862 kPa).
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
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. [BrassCraft Manufacturing Company; a Masco company.](#)
 - b. [Conbraco Industries, Inc.; Apollo Div.](#)
 - c. [Lyll, R. W. & Company, Inc.](#)
 - d. [McDonald, A. Y. Mfg. Co.](#)
 - e. [Perfection Corporation; a subsidiary of American Meter Company.](#)
 2. Body: Bronze, complying with ASTM B 584.
 3. Ball: Chrome-plated bronze.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig (4140 kPa).
 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.
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. [Lee Brass Company.](#)
 - b. [McDonald, A. Y. Mfg. Co.](#)
 2. Body: Bronze, complying with ASTM B 584.
 3. Plug: Bronze.
 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Operator: Square head or lug type with tamperproof feature where indicated.
 6. Pressure Class: 125 psig (862 kPa).
 7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. PE Ball Valves: Comply with ASME B16.40.
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. [Kerotest Manufacturing Corp.](#)
 - b. [Lyll, R. W. & Company, Inc.](#)
 - c. [Perfection Corporation; a subsidiary of American Meter Company.](#)
 2. Body: PE.
 3. Ball: PE.
 4. Stem: Acetal.
 5. Seats and Seals: Nitrile.
 6. Ends: Plain or fusible to match piping.
 7. CWP Rating: 80 psig (552 kPa).

8. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

G. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.05 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

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. [Actaris](#).
 - b. [American Meter Company](#).
 - c. [Fisher Control Valves and Regulators; Division of Emerson Process Management](#).
 - d. [Invensys](#).
 - e. [Richards Industries; Jordan Valve Div.](#)
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig (690 kPa).

2.06 SERVICE METERS

- A. Rotary-Type Service Meters: Comply with ANSI B109.3.
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. [American Meter Company](#).
 - b. [Invensys](#).
 2. Case: Extruded aluminum.
 3. Connection: Flange.
 4. Impellers: Polished aluminum.
 5. Rotor Bearings: Self-lubricating.
 6. Compensation: Continuous temperature and pressure.
 7. Meter Index: Cubic feet.
 8. Tamper resistant.
 9. Remote meter reader compatible.
 10. Maximum Inlet Pressure: 100 psig (690 kPa).
 11. Accuracy: Maximum plus or minus 2.0 percent.
- B. Turbine Meters: Comply with ASME MFC-4M.
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. [American Meter Company](#).
 - b. [Invensys](#).
 2. Housing: Cast iron or welded steel.
 3. Connection Threads or Flanges: Steel.
 4. Turbine: Aluminum or plastic.
 5. Turbine Bearings: Self-lubricating.
 6. Compensation: Continuous temperature and pressure.
 7. Meter Index: Cubic feet.
 8. Tamper resistant.
 9. Remote meter reader compatible.
 10. Maximum Inlet Pressure: 100 psig (690 kPa).
 11. Accuracy: Maximum plus or minus 2.0 percent.

2.07 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.03 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 02300 "Earthwork" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.

3.04 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- P. Connect branch piping from top or side of horizontal piping.
- Q. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- R. Do not use natural-gas piping as grounding electrode.
- S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

3.05 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install service-meter assemblies aboveground.

- B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- C. Install strainer on inlet of service-pressure regulator and meter set.
- D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.

3.06 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.07 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 2. Cut threads full and clean using sharp dies.
 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 5. 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.
- D. Welded Joints:
 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. 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.

3.08 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 15074 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Section 15062 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
 - 2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 - 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 - 4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
 - 5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).
- D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
 - 2. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
 - 3. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
 - 4. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
- E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

3.09 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 15077 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in Section 09900 "Painting" for painting interior and exterior natural-gas piping.
- B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 21 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Coating for steel piping.

3.15 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
 - 1. PE valves.
 - 2. NPS 2 and Smaller: Bronze plug valves.
 - 3. NPS 2-1/2 and Larger: Cast-iron, nonlubricated plug valves.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be[**one of**] the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated plug valve.

- E. Valves in branch piping for single appliance shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.

END OF SECTION

SECTION 15446 - SUMP PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.
 - 2. Sump-pump basins and basin covers.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.05 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.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS

- A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Zoeller Company 59 Series
 2. Description: Factory-assembled and -tested sump-pump unit.
 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Pump Casing: Bronze, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 5. Impeller: Statically and dynamically balanced, Bronze design for clear wastewater handling, and keyed and secured to shaft.
 6. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
 7. Seal: Mechanical.
 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
 9. Controls:
 - a. Switch Type: Mercury-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.

2.02 SUMP PUMP CAPACITIES AND CHARACTERISTICS

- A. See Equipment Schedule

2.03 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
1. Material: Polyethylene.
 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
 3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
1. Reinforcement: Galvanized or Stainless Steel, capable of supporting foot traffic for basins installed in foot-traffic areas.

- C. Capacities and Characteristics:
 - 1. See Plans
 - 2. Cover Material: Galvanized or Stainless Steel.
 - 3. Cover Diameter: Same as sump.
 - 4. Manhole Required in Cover: No.
 - 5. Vent Size: 2 NPS.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.02 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.03 CONNECTIONS

- A. Comply with requirements for piping specified in Section 15160 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.04 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. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Provide the owner with documentation of the startup service and copies the startup checklists

3.06 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.07 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 15546 - LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes low-intensity, gas-fired, forced-draft radiant heaters.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Signed, sealed, and prepared by or under the supervision of a qualified professional engineer.
 - 2. Include plans, elevations, sections, and mounting details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Detail fabrication and assembly of high-intensity, gas-fired, radiant heaters, as well as procedures and diagrams.
 - 5. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which equipment will be attached.
 - 2. Gas piping to heater installations
 - 3. Thermostats and wiring to heaters.
 - 4. Heater locations and clearance requirements.
 - 5. Other suspended ceiling components including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's special warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For gas-fired, radiant heaters to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Igniter: One hot-surface burner igniter(s) for each style of high-intensity, gas-fired, radiant heater furnished.

1.07 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: All warranty periods listed below are from date of Substantial Completion.
 - a. Burner Assembly: Five years.
 - b. Combustion and Emitter Tubes: Three years.
 - c. Heater Controls: One year(s).

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

2.02 FORCED-DRAFT HEATERS

- 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. [Calcana Industries Ltd.](#)
 - 2. [Combustion Research Corporation.](#)
 - 3. [Detroit Radiant Products Company.](#)
 - 4. [Roberts-Gordon, LLC.](#)
 - 5. [Schwank Group.](#)
 - 6. [Solaronics, Inc.](#)
 - 7. [Space-Ray; Division of Gas Fired Products, Inc.](#)
 - 8. [Sterling Heating, Ventilation & Air-Conditioning Products; a Mestek company.](#)
 - 9. [Thomas & Betts Corporation.](#)
- B. Description: Factory-assembled, indoor, overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.
- C. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

- D. Burner Assembly:
 1. Combustion-Air Inlet: Ducted horizontal to outdoors through sidewall with vent caps.
 2. Burner Control Housing: Totally enclosed steel exterior with steel cover and enameled finish or powder-coated finish. A sight glass is supplied for visual inspection of the burner.
 3. Burner: Aluminized Steel.
 4. Ignition System: Silicon carbide hot-surface igniter with flame rod sensing capabilities.
 5. Combustion Blower Fan: Dynamically balanced, direct-driven, forward-curved fan with cast-aluminum-alloy or stainless-steel impeller and aluminized-steel housing, with a minimum temperature rating of 450 deg F (232 deg C).

- E. Combustion Chamber: 4-inch- (100-mm-) diameter, 16-gage, titanium-coated aluminized-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

- F. Emitter Tube: 4-inch- (100-mm-) diameter, 16-gage, aluminized-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.
 1. Tubing Connections: Interlocking flare joints with stainless-steel draw bolts.

- G. Reflector: Polished aluminum, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

- H. Accessories:
 1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
 2. Protective grilles mounted to reflectors to protect emitter tubing.
 3. Stainless-steel flexible connector with manual valve for gas supply.
 - 4.
 5. 3/16-inch- (5-mm-) diameter, aluminized-steel wire tubing hangers and reflector supports.
 6. Rigid mounting kits.
 7. Clearance warning plaque.

- I. Capacities and Characteristics:
 1. Refer to Equipment schedule on drawings for capacity

2.03 CONTROLS AND SAFETIES

- A. Gas Control Valve: Single-stage, regulated redundant 24-V ac gas valve that contains pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

- B. Failure Safeguards: 100 percent shutoff of gas flow in the event of flame or power failure.

- C. Prepurge of 45 seconds of air control system prior to burner ignition.

- D. Safety lockout of burner after flame is not reestablished within trial ignition period.

- E. Indicator Lights: "Airflow-on" and "burner-on" indicator lights.
- F. Thermostat: Single-stage, wall-mounted type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.
 - 1. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine structures, substrates, areas and conditions, with Installer present, for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance of the Work.
- B. Examine roughing-in for fuel-gas piping to verify actual locations of piping connections before equipment installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to NFPA 54.
- B. Suspended Units: Mount to substrate using manufacturer's rigid mounting kits or custom fabricated brackets.
 - 1. Comply with requirements for hangers and supports specified in Section 15062 "Hangers and Supports for HVAC Piping and Equipment."
- C. Maintain manufacturers' recommended clearances for combustibles.

3.03 CONNECTIONS

- A. Gas Piping: Comply with Section 15195 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
 - 1. Gas Connections: Connect gas piping to radiant heaters according to NFPA 54.
- B. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.
- C. Vent Connections: Comply with Section 15815 "Metal Ducts" and with Section 15550 "Breechings, Chimneys, and Stacks."
- D. Electrical Connections: Comply with applicable requirements in Division 16000
 - 1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust initial-temperature set points.
- B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.06 STARTUP

- A. Manufacturer's representative shall provide startup services the fan systems. Manufacturer's startup checklist shall be completed. Startup shall also include operation of the manufacturer's supplied controls, VFDs, and motor starters. The equipment startup shall verify the equipment operates per the contract documents and approved shop drawings.
- B. Provide a written report of the start-up process and provide copies of the start-up checklist for each piece of equipment

3.07 TRAINING

- A. Manufacturer's representative shall provide training to the owner's operators. Training shall cover the operation of the unit and routine maintenance of the equipment. Training shall be scheduled with owner with minimum of 10 working days' notice or otherwise approved time. Training shall be conducted after successful startup of the equipment.

END OF SECTION

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SECTION 15550 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Listed double-wall vents.
- B. Related Sections include the following:

1.03 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Type B and BW vents.
- B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
 - 2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LISTED TYPE B AND BW VENTS

- 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. [American Metal Products](#); MASCO Corporation.
 2. [Cleaver-Brooks](#); Div. of Aqua-Chem Inc.
 3. [FAMCO](#).
 4. [Hart & Cooley, Inc.](#)
 5. [Heat-Fab, Inc.](#)
 6. [Industrial Chimney Company](#).
 7. [LSP Products Group, Inc.](#)
 8. [Metal-Fab, Inc.](#)
 9. [Schebler Co. \(The\)](#).
 10. [Selkirk Inc.](#); Selkirk Metalbestos and Air Mate.
 11. [Simpson Dura-Vent Co., Inc.](#); Subsidiary of Simpson Manufacturing Co.
 12. [Tru-Flex Metal Hose Corp.](#)
 13. [Van-Packer Company, Inc.](#)
- B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B, or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.
- D. Inner Shell: ASTM B 209 (ASTM B 209M), Type 1100 aluminum or ASTM B 209 (ASTM B 209M), Type 3003 aluminum or ASTM B 209 (ASTM B 209M), Type 3105 aluminum or ASTM A 666, Type 430 stainless steel.
- E. Outer Jacket: Galvanized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
1. Termination: Vent Cap

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION

- A. Listed Type B and BW Vents: Vents for certified gas appliances.

3.03 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- E. Lap joints in direction of flow.
- F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.
- G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
- H. Erect stacks plumb to finished tolerance of no more than 1 inch (25 mm) out of plumb from top to bottom.

3.04 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION

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SECTION 15734 - COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ceiling-mounted computer-room air conditioners.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 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.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

1.07 SPARE PARTS

- A. Provide the following spare parts for each piece of equipment provided:
 - 1. Spare Filters
 - 2. Spare belt

PART 2 - PRODUCTS

2.01 CEILING-MOUNTED UNITS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. [Compu-Aire, Inc.](#)
 - 2. [Data Aire Inc.](#)
 - 3. [Liebert Corporation.](#)
 - 4. [Stulz-ATS.](#)
- B. Description: Split System Unit with remote indoor condenser, factory assembled, prewired, and with manufacturer's line set between evaporator and condenser; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting.
- C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch- (13-mm-) thick duct liner.
 - 1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.
- E. Refrigeration System:
 - 1. Condenser: Indoor Air-Cooled Centrifugal Fan Condensing Unit.
 - 2. Compressor: Scroll compressor. Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
 - 3. Refrigeration Circuit: High-pressure switch, head pressure control system, hot gas bypass and liquid line solenoid valve. The unit shall include thermal-expansion valve, equalizer, sight glass with moisture indicator, service shutoff valves, charging valve, and refrigerant charge.
 - 4. Operating Temperatures: Unit shall be capable of operating with outdoor air temperatures for negative 30°F to 95°F.
 - 5. Refrigerant: R-407C or R-410A.
 - 6. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1.
 - 7. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection. Provide refrigerant piping between the evaporator and the remote condensing unit.

- F. Electric-Resistance Heating Coil: SCR Electric Reheat, Provide SCR controller and unit control to provide full cooling with modulating of the electric reheat elements to control air temperatures. Reheat capacity shall be upsized to offset the cooling capacity.
- G. Filter: 1-inch- (25-mm-) thick, disposable, glass-fiber media.
 - 1. Initial Resistance: 0.10 inches wg.
 - 2. Recommended Final Resistance: 0.50 inches wg.
 - 3. Merv (ASHRAE 52.2): 8.
- H. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- I. Control System:
 - 1. Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature-control modules, time-delay relay, Heating contactor, and high-temperature thermostat.
 - 2. Wall mounted control: Provide solid-state, wall-mounted control panel with the following controls and features:
 - a. Start/Stop unit.
 - b. Temperature setpoint adjustment.
 - c. Fan speed.
 - d. Alarms and alarm silence.
 - e. Digital temperature display.
 - f. Unit shall automatically restart after a power outage.
- J. Unit Accessories:
 - 1. Filter Box Kit: Provide filter box kit which mounts to the return air flange on the unit. Provide with MERV 8 filter.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.
- B. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and elastomeric hangers of size required to support weight of computer-room air conditioner.
 - 1. Comply with requirements for hangers and supports specified in Section 15062 "Hangers and Supports for HVAC Piping and Equipment."
- C. Air-Cooled Refrigerant Condenser Mounting: Install using continuous-thread hanger rods and elastomeric hangers of size required to support weight of the condensing unit.
 - 1. Comply with requirements for hangers and supports specified in Section 15062 "Hangers and Supports for HVAC Piping and Equipment."

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Section 15140 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- D. Refrigerant Piping: Comply with manufacturer's requirements
- E. Drain Piping and Refrigerant piping: Do not route piping systems above electrical equipment.

3.03 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. After startup service and performance test, change filters and flush humidifier.

3.04 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 STARTUP

- A. Manufacturer's representative shall provide startup services on the unit and complete the Manufacturer's startup check list. The startup shall include but not limited to: Refrigerant leak checks, fan operation and direction, amperage readings on the fans and compressor, measuring return and supply air temperatures, cycling the unit, testing the reheat system, programming the remote panel, and inspection the unit for correct installation and defects.

- B. The manufacturer's representative shall provide a written report of the startup and provide a list of any deficiencies. The report shall be submitted to the owner prior to the training.

3.06 TRAINING

- A. Manufacturer's representative shall provide operator training on the use of the unit controls and setting adjustment. The training shall also include routine maintenance on the Air Conditioner Unit and Remote Condenser Unit. Training shall be completed after the equipment has been successfully started and operational. The training session and Start-Up services shall be considered to be conducted on separate business days. Manufacturer shall provide at 10 business day notice to the prior to training session unless otherwise agreed to by the owner.

END OF SECTION

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SECTION 15815 - METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Sealants and gaskets.
 - 3. Hangers and supports.
- B. Related Sections:
 - 1. Section 15820 "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 - 2. Section 15950 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Sealants and gaskets.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Equipment installation based on equipment being used on Project.
 - 5. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 6. Hangers and supports, including methods for duct and building attachment and vibration isolation.

- C. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: 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. Duct adaptor (Shroud) between the generator and the wall louver/damper assembly
- B. Welding certificates.
- C. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SHEET METAL MATERIALS

- A. General Material Requirements: 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.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 (Z180).
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- E. 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).

2.03 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 4 inches (102 mm).
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 11. Sealant 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. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 7. Sealant 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. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.04 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 15820 "Duct Accessories."

- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09900 "Painting"

3.07 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

3.08 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 15820 "Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.09 START UP

- A. Air Balance: Comply with requirements in Section 15950 "Testing, Adjusting, and Balancing."

3.10 DUCT SCHEDULE

- A. Supply Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 3-inch wg (750 Pa).
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
- B. Exhaust Ducts:
 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
- C. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 1. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.

- D. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.

- E. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm (5 m/s) or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm (7.6 m/s) or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

END OF SECTION

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SECTION 15820 - DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Insulated Control dampers.
 - 3. Flange connectors.
 - 4. Duct-mounted access doors.
 - 5. Flexible connectors.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 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. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- 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 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.

2.02 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 (Z180).
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. 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).

2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- 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. [Air Balance Inc.; a division of Mestek, Inc.](#)
 - 2. [American Warming and Ventilating; a division of Mestek, Inc.](#)
 - 3. [Cesco Products; a division of Mestek, Inc.](#)
 - 4. [Greenheck Fan Corporation.](#)
 - 5. [Lloyd Industries, Inc.](#)
 - 6. [Nailor Industries Inc.](#)
 - 7. [NCA Manufacturing, Inc.](#)
 - 8. [Pottorff.](#)
 - 9. [Ruskin Company.](#)
 - 10. [Vent Products Company, Inc.](#)
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1250 fpm (6.4 m/s) .
- D. Maximum System Pressure: 1-inch wg (0.25 kPa).
- E. Frame: Hat-shaped, 18 gauge, galvanized sheet steel, with welded corners or mechanically attached.
- F. Blades: Multiple single-piece blades, off-center pivoted, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges.

- G. Blade Action: Parallel.
- H. Blade Seals: Vinyl foam.
- I. Blade Axles:
 - 1. Material: Galvanized steel.
 - 2. Diameter: 0.20 inch (5 mm).
- J. Tie Bars and Brackets: Aluminum or Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.

2.04 INSULATED CONTROL DAMPERS

- 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. [American Warming and Ventilating; a division of Mestek, Inc.](#)
 - 2. [Arrow United Industries; a division of Mestek, Inc.](#)
 - 3. [Cesco Products; a division of Mestek, Inc.](#)
 - 4. [Greenheck Fan Corporation.](#)
 - 5. [Ruskin Company.](#)
- B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 - 1. 0.125 inch aluminum channel frame.
 - 2. Mitered and welded corners.
- D. Blades:
 - 1. Multiple blade with maximum blade width of 6 inches (152 mm).
 - 2. Parallel-blade design.
 - 3. Aluminum airfoil blade internally insulated polyurethane foam and thermally broken.
 - 4. Blade Seal: Silicone rubber
 - 5. Jamb Seal: 304 stainless steel.
- E. Blade Axles: 1/2-inch- (13-mm-) diameter; galvanized steel, stainless steel, or nonferrous metal; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
- F. Bearings:
 - 1. Dual bearing with acetal inner sleeve, flanged outer bearing

2.05 FLANGE CONNECTORS

- 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. [Ductmate Industries, Inc.](#)
 2. [Nexus PDQ; Division of Shilco Holdings Inc.](#)
 3. [Ward Industries, Inc.; a division of Hart & Cooley, Inc.](#)
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.06 DUCT-MOUNTED ACCESS DOORS

- 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. [American Warming and Ventilating; a division of Mestek, Inc.](#)
 2. [Cesco Products; a division of Mestek, Inc.](#)
 3. [Ductmate Industries, Inc.](#)
 4. [Flexmaster U.S.A., Inc.](#)
 5. [Greenheck Fan Corporation.](#)
 6. [McGill AirFlow LLC.](#)
 7. [Ventfabrics, Inc.](#)
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - d. 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 (300 mm) Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches.
 - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

2.07 FLEXIBLE CONNECTORS

- 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. [Ductmate Industries, Inc.](#)
 - 2. [Duro Dyne Inc.](#)
 - 3. [Elgen Manufacturing.](#)
 - 4. [Ventfabrics, Inc.](#)
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal 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.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Upstream from, control dampers, and at equipment connections (generator).
 - 2. Control devices requiring inspection.
 - 3. Elsewhere as indicated.
- E. Install access doors with swing against duct static pressure.

- F. Access Door Sizes:
 - 1. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
 - 2. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
 - 3. Body Access: 25 by 14 inches (635 by 355 mm).
- G. Label access doors according to Section 15077 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- H. Install flexible connectors to connect ducts to equipment.

3.02 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.

END OF SECTION

SECTION 15838 - POWER VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Centrifugal wall ventilators.
 - 2. Propeller fans.

1.03 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Fan speed controllers.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, 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. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

1.08 SPARE PARTS

- A. Provide the following spare parts for each Fan supplied
 - 1. Belts: One set for each belt-driven unit
 - 2. Filters: One complete set for each unit with filters.

1.09 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.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.10 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL WALL VENTILATORS

- 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. [Acme Engineering & Manufacturing Corporation.](#)
 - 2. [Aerovent; a division of Twin City Fan Companies, Ltd.](#)
 - 3. [American Coolair Corporation.](#)
 - 4. [Ammerman; Millennium Equipment.](#)
 - 5. [Carnes Company.](#)
 - 6. [Greenheck Fan Corporation.](#)
 - 7. [Hartzell Fan Incorporated.](#)

8. [JencoFan](#).
 9. [Loren Cook Company](#).
 10. [PennBarry](#).
- B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
- C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- D. Direct Drive:
1. Electronically Commutated Motor with speed control mounted on motor.
 - a. Motor enclosures: Open type
 - b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 - c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
 - d. DInternal motor circuitry to convert AC power supplied to the fan to DC over to operate the motor.
 - e. EMotor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - f. Motor shall be a minimum of 85% efficient at all speeds.
- E. Accessories:
1. Motor Speed Controller: Mounted at the fan with potentiometer for speed adjustment
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
 3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
 4. Wall Grille: Ring type for flush mounting.
 5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
- F. Capacities and Characteristics:
1. Refer to Schedule on drawings

2.02 PROPELLER FANS

- 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. [Aerovent; a division of Twin City Fan Companies, Ltd.](#)
 2. [Hartzell Fan Incorporated](#).
 3. [JencoFan](#).
 4. [Loren Cook Company](#).
 5. [PennBarry](#).
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- C. Cast aluminum airfoil blade propeller: Ball bearing motors – Corrosion resistant fasteners

- D. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- F. Fan Drive:
 - 1. Resiliently mounted to housing.
 - 2. Statically and dynamically balanced.
 - 3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 4. Extend grease fitting to accessible location outside of unit.
 - 5. Service Factor Based on Fan Motor Size: 1.4.
 - 6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 8. Motor shall be VFD rated.
- G. Accessories:
 - 1. Dampers: motorized damper, thermal broken insulated control damper. See specification 15820 – Duct Accessories for damper requirements
 - 2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 - 3. Wall Sleeve: Galvanized steel to match fan and accessory size.
 - 4. Weathershield Hood: Aluminum, 90 Degree to match fan and accessory size. Provide with Aluminum bird screen.
 - 5. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. Controller shall be capable of receiving two digital inputs for a two stage cooling thermostat to control fan speed high/low speed. Fan speed shall be field programmable
 - 6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 7. V-Filter Rack: Provide Filter Wall housing section with side access for filter removal.
 - 8. Diffuser: Provide 2-way diffuser on fan discharge to the room. Diffuser shall provide horizontal and vertical adjustment of airflow. Position of diffuser shall be lockable by bolt or other method to prevent movement of diffuser after adjustment.
 - 9. Intake Screen: Provide Heavy Duty Commercial Grade Cottonwood Filter on the weather hood intake. See Specification 10200 – “Aluminum Louvers and Vents” article “Cottonwood Filter” for specifications on the intake filter.
- H. Capacities and Characteristics:
 - 1. Refer to the Equipment Schedule on the Plans

2.03 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15058 "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.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.04 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of less than 1 inch (25 mm). Install units with clearances for service and maintenance.
- C. Label units according to requirements specified in Section 15077 "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 15820 "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 16060 "Grounding and Bonding."
- D. Connect wiring according to Section 16120 "Conductors and Cables."

3.03 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. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 15950 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.05 STARTUP

- A. Manufacturer's representative shall provide startup services the fan systems. Manufacturer's startup checklist shall be completed. Startup shall also include operation of the manufacturer's supplied controls, VFDs, and motor starters. The equipment startup shall verify the equipment operates per the contract documents and approved shop drawings.
- B. Provide a written report of the start-up process and provide copies of the start-up checklist for each piece of equipment

3.06 TRAINING

- A. Manufacturer's representative shall provide training to the owner's operators. Training shall cover the operation of the unit and routine maintenance of the equipment. Training shall be scheduled with owner with minimum of 10 working days' notice or otherwise approved time. Training shall be conducted after successful startup of the equipment.

END OF SECTION

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
1. Adjustable bar registers and grilles.
 2. Fixed face registers and grilles.
- B. Related Sections:
1. Section 15820 "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 ACTION SUBMITTALS

- A. 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.

PART 2 - PRODUCTS

2.01 REGISTERS AND GRILLES

- A. Adjustable Bar Grille:
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. [Carnes](#).
 - b. [Krueger](#).
 - c. [METALAIRE, Inc.](#)
 - d. [Price Industries](#).
 - e. [Titus](#).
 - f. [Tuttle & Bailey](#).
 2. Material: Aluminum.
 3. Finish: Baked enamel, white.
 4. Face Blade Arrangement: Vertical spaced 3/4 inch (19 mm) apart.
 5. Core Construction: Integral.
 6. Rear-Blade Arrangement: Horizontal spaced 3/4 inch (19 mm) apart.
 7. Frame: 1-1/4 inches (32 mm) wide.
 8. Mounting: Countersunk screw.

B. Fixed Face Grille:

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. [Carnes](#).
 - b. [Krueger](#).
 - c. [Price Industries](#).
 - d. [Titus](#).
 - e. [Tuttle & Bailey](#).
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch (13-by-13-by-13-mm) grid core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches (32 mm) wide.
7. Mounting: Countersunk screw.

2.02 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."

PART 3 - EXECUTION

3.01 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.

3.02 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 15856 - INTAKE AND RELIEF VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Louvered-penthouse ventilators.
 - 2. Roof hoods.
 - 3. Goosenecks.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft., acting inward or outward.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
 - 1. Temperature Change (Range): 120 deg F (67 deg C),(100 deg C), material surfaces.
- C. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.04 ACTION SUBMITTALS

- A. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof framing plans and other details, 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 to which roof curbs and ventilators will be attached.
 - 2. Sizes and locations of roof openings.

1.06 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.
- B. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use hex-head-head screws for exposed fasteners unless otherwise indicated.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- D. Gasket: provide neoprene gasket material between hood and the roof curb. Do not use adhesive type sealants to seal the hood to the curb.

2.02 FABRICATION, GENERAL

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.03 ROOF HOODS

- 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. [Acme Engineering & Mfg. Corporation.](#)
 - 2. [Aerovent.](#)
 - 3. [Carnes.](#)
 - 4. [Greenheck Fan Corporation.](#)
 - 5. [JencoFan.](#)
 - 6. [Loren Cook Company.](#)
 - 7. [PennBarry.](#)

- B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.
- C. Materials: Galvanized-steel sheet, minimum 0.064-inch- (1.62-mm-) thick base and 0.040-inch- (1.0-mm-) thick hood; suitably reinforced.
- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall Height: 12 inches (300 mm).
- E. Bird Screening: Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire.
- F. Galvanized-Steel Sheet Finish:
 - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
 - 2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
 - 3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.
- G. Capacities and Characteristics:
 - 1. Width and Depth: See equipment Schedule on drawings
 - 2. Air Performance: Not more than 0.15-inch wg (25-Pa) static pressure drop at 800-fpm (4.1-m/s) free-area exhaust velocity.
 - 3. Accessories:
 - a. Gravity Backdraft damper: See specification 15820 – Duct Accessories. Gravity damper shall be mounted inside the relief hood such that the damper is removed with the relief hood,
 - b. Lifting Lugs: provide permanently installed lifting lugs on the hood.
 - c. Provide neoprene or rubber gasket material between the hood and curb. Adhesive type sealants shall not be used.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Install gravity ventilators with clearances for service and maintenance.

- C. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- D. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.02 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF SECTION

SECTION 15950 – TESTING ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.

1.03 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.04 INFORMATIONAL SUBMITTALS

- A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.
- C. Sample report forms.
- D. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.05 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Owner.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.06 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.07 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 TAB SPECIALISTS

- A. Subject to compliance with requirements, available TAB contractors that may be engaged include, but are not limited to, the following:
 - 1. Aerodynamics Inspecting Company
 - 2. Aires
 - 3. Enviro-Aire
 - 4. Great Lakes Balancing

3.02 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine operating safety interlocks and controls on HVAC equipment.

- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.03 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Windows and doors can be closed so indicated conditions for system operations can be met.

3.04 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 15820 "Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 15086 "Duct Insulation," Section 15087 "HVAC Equipment Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.05 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.

- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections and functioning.
- I. Check for proper sealing of air-handling-unit components.
- J. Verify that air duct system is sealed as specified in Section 15815 "Metal Ducts."

3.06 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.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. 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.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. 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.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. 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.
 - 6. Obtain approval from Owner 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.
 - 7. 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, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain 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.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. 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.

3.07 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.08 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.09 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.

3.10 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems'

balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).
 - i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.

- d. Number of rows.
 - e. Fin spacing in fins per inch (mm) o.c.
 - f. Make and model number.
 - g. Face area in sq. ft. (sq. m).
 - h. Tube size in NPS (DN).
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Average face velocity in fpm (m/s).
 - c. Air pressure drop in inches wg (Pa).
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
 - e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
 - f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
 - h. Water flow rate in gpm (L/s).
 - i. Water pressure differential in feet of head or psig (kPa).
 - j. Entering-water temperature in deg F (deg C).
 - k. Leaving-water temperature in deg F (deg C).
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig (kPa).
 - n. Refrigerant suction temperature in deg F (deg C).
 - o. Inlet steam pressure in psig (kPa).
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h (kW).
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches (mm), and bore.
 - n. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 2. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm (L/s).
 - b. Entering-air temperature in deg F (deg C).
 - c. Leaving-air temperature in deg F (deg C).
 - d. Air temperature differential in deg F (deg C).
 - e. Entering-air static pressure in inches wg (Pa).
 - f. Leaving-air static pressure in inches wg (Pa).
 - g. Air static-pressure differential in inches wg (Pa).

- h. Low-fire fuel input in Btu/h (kW).
 - i. High-fire fuel input in Btu/h (kW).
 - j. Manifold pressure in psig (kPa).
 - k. High-temperature-limit setting in deg F (deg C).
 - l. Operating set point in Btu/h (kW).
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h (kW).
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h (kW).
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm (L/s).
 - i. Face area in sq. ft. (sq. m).
 - j. Minimum face velocity in fpm (m/s).
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h (kW).
 - b. Air flow rate in cfm (L/s).
 - c. Air velocity in fpm (m/s).
 - d. Entering-air temperature in deg F (deg C).
 - e. Leaving-air temperature in deg F (deg C).
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).

- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F (deg C).
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Indicated air flow rate in cfm (L/s).
 - h. Indicated velocity in fpm (m/s).
 - i. Actual air flow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).

- K. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft. (sq. m).
 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary air flow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final air flow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).

- L. Instrument Calibration Reports:
 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.12 INSPECTIONS

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 - 2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - c. Verify that balancing devices are marked with final balance position.
 - d. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:
 - 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
 - 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Construction Manager.
 - 3. Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
 - 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

- E. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- F. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 16050 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 16.
- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. CONTRACTOR shall fully coordinate electrical Work with other trades to avoid interferences.
 - 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
 - 1. Submit product data covering the items included under this Section of Work.
- B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to ENGINEER in digital format.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's 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.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with requirements in Section 01770. In addition, CONTRACTOR shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.

- B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor, motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

1.04 QUALITY ASSURANCE

- A. National Electrical Code: Comply with NFPA 70, National Electrical Code.
- B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

- A. CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
 - 1. Upon completion of Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

- A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
 - 1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).

- B. Provide nonmetallic electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.
- C. Coordinate with power company high voltage and/or low voltage metering requirements. Furnish, install, and connect metering equipment not furnished, installed or connected by power company.
- D. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- E. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- F. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.
- G. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- H. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- 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. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- K. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Section 08310.
- L. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 RACEWAY INSTALLATION

- A. Outdoors, use the following materials:
 1. Exposed Conduit: PVC externally coated rigid metal conduit and fittings.
 2. Underground Concrete Encased Conduit: Rigid nonmetallic conduit.
 3. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.

- B. Indoors, use the following wiring materials:
 - 1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
 - 2. Exposed Conduit: Rigid metal conduit or intermediate metal conduit.
 - a. Exceptions:
 - 1) Areas indicated as NEMA 4X, use rigid Schedule 40 PVC conduit.
 - 3. Concealed Conduit: Rigid metal conduit or intermediate metal conduit unless indicated otherwise.
- C. Minimum size conduit shall be 3/4 inch unless shown otherwise.
- D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit. Conduit shall be RMC or PVC-coated RMC.
- E. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.
- F. Install expansion fittings in all exposed rigid nonmetallic conduit runs of 20 feet or more.
- G. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.
- H. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.
- I. Concealed Raceways: Raceways embedded in slabs shall be installed in the middle third of the slab thickness where practical and leave at least 1-inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run 1-inch and smaller raceways with a minimum of bends in the shortest practical distance. Run larger conduit parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit or fiberglass-reinforced conduit is used, raceways must be converted to PVC externally coated rigid metal conduit before rising above floor.
- J. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. 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.

- K. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.
- L. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.
- M. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.
- N. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.
- O. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- P. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- Q. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal 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 and elsewhere as indicated:
 - 1. Where required by the NEC.
- R. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- S. Install device boxes at the height above the floor as follows for:
 - 1. Light switches, 4 feet.
 - 2. Receptacles, 18 inches except in NEMA 4 and 4X areas, 4 feet.
 - 3. Thermostats, 4'-0".
- T. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.
- U. Position recessed outlet boxes accurately to allow for surface finish thickness.

- V. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.
- W. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.
- X. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- Y. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.
- Z. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.
- AA. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- BB. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

- A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.
- B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.
- C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.
- D. Provide adequate length of conductors within electrical enclosures and train 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 terminal.
- E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller

within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.

F. Seal wire and cable ends until ready to splice or terminate.

3.04 CUTTING AND PATCHING

- A. Perform cutting and patching in accordance with requirements in Section 02225. In addition, the following requirements apply.
1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover Work to provide for installation of ill-timed Work, remove and replace Work that is either defective or does not conform to requirements of Drawings.
 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by new Work. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
 3. Patch existing finished surfaces and building components using new materials matching existing materials.

3.05 EQUIPMENT CHECKOUT AND TESTING

- A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.
- B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:

$$\begin{aligned} R_{\min.} &= 4 (KV + 1) \text{ at } 25 \text{ degrees C winding temp.} \\ R_{\min.} &= IV + 1 \text{ at } 40 \text{ degrees C winding temp.} \end{aligned}$$

1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.
 2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.
- C. Equipment Testing: The following tests which are applicable for a particular item of equipment shall be performed:
1. Megger bus work phase-to-phase and phase-to-ground. Minimum acceptable steady-state value is 100 megohms.
 2. Megger power circuit breakers and circuits supplied phase-to-phase and phase-to-ground (100 megohms minimum).
 3. Test current transformer circuits by applying current to secondary wiring at current transformer terminals until contactor trips.
 4. Test, time, and set protective relays. Relays shall be timed at various multiples (minimum of 3 points) of the pick-up value to determine agreement with published curves and adjust as

- necessary to agree with coordination study required settings. Exact tests to be performed vary with type of relay. Manufacturer's instructions for relay shall be complied with.
5. After Work has been completed, demonstrate to OWNER's Representative that entire electrical installation is in proper working order and will perform functions for which it was designed by functional testing.
 6. Make any specific tests required by the manufacturer's installation instructions.
- D. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
1. Vacuum interior of cubicles and remove foreign material.
 2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
 3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or ENGINEER.
 4. Fill motor bearings requiring oil.
 5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.
 6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
 7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
 8. Check exposed bolted power connections for tightness.
 9. Check operation of breakers, contactors, etc., and control and safety interlocks.
 10. Check tightness of bolted structural connections.
 11. Check leveling and alignment of enclosures.
 12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
 13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
 14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

SECTION 16052 - COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Provide Coordination Study detailing electrical system protection, protective equipment selectivity and arc flash hazard analysis studies.
1. The report shall include the following sections:
 - a. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
 - b. Descriptions, purpose, basis and scope of the study
 - c. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
 - d. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
 - e. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
 - f. Incident energy and flash protection boundary calculations
 - g. Comments and recommendations for system improvements, where needed
 - h. Executive Summary including source of information and assumptions made

1.02 COORDINATION STUDY

- A. Include as part of Contract a complete Coordination and Short Circuit Study from incoming power lines through the high voltage switchgear, unit substations, and the motor control centers branch circuits. Obtain available short circuit current, inrush current, and upstream protective device time current curves from the power company. Include power company current data and protective device curve as part of study. Study shall include all coordinating curves with each fuse size, trip settings, and thermal overloads given for connected loads. Curves shall include feeder wire melting curves and transformer ANSI rating points. The study shall also include variable frequency drives for motors larger than 40 Hp, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear. Fuse sizes on motor control centers shall be those shown in Drawings throughout the short circuit and coordination study. Changes in loads from those shown on Drawings shall be incorporated in Study.
- B. Contractor shall furnish all field data as required for the power system studies and arc flash hazard analysis studies. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
- C. Studies shall be performed by a major electrical supplier (i.e., S&C, G.E., Westinghouse) local power company or equal. Study results shall be submitted to ENGINEER for approval.

- D. After approval all electrical equipment settings, thermal overloads, and fuses shall be made to conform to approved results. CONTRACTOR shall test all trip settings, time delays, and indicating devices on all switchgear, unit substations, and motor control centers. Tests shall be witnessed by ENGINEER.
- E. Data sheets for test are to be furnished by CONTRACTOR and shall be filled out showing the desired settings from Coordination Study and results obtained from witnessed test. Data sheets shall be signed by those performing test and witness. Test data sheets and motor list showing fuses, thermal overload sizes, etc. shall be submitted to ENGINEER as part of Contract.

1.03 ARC FLASH HAZARD ANALYSIS

- A. Include as part of Contract a complete Arc Flash Hazard analysis from incoming power lines through the switchgear, unit substations, and the motor control centers branch circuits. Obtain available short circuit current, inrush current, and upstream protective device time current curves from the power company. Include power company current data and protective device curve as part of study. Analysis shall include all each fuse size, trip settings, and thermal overloads given for connected loads, and shall include feeder wire distances and transformer ANSI rating points. The study shall also include variable frequency drives for motors larger than 40 Hp, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives and distribution switchgear. Fuse sizes and circuit breakers on motor control centers shall be those shown in Drawings throughout the Analysis. Changes in loads from those shown on Drawings shall be incorporated in Analysis.
- B. Contractor shall furnish all field data as required for the power system studies and arc flash hazard analysis studies. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
- C. Studies shall be performed by a major electrical supplier (i.e., S&C, G.E., Westinghouse), local power company or equal. Study results shall be submitted to Engineer for approval

PART 2 - PRODUCTS

2.01 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition. Transformer design impedances and standard X/R ratios shall be used when test values are not available.
- B. Provide the following information in the study report:
 - 1. Calculation methods and assumptions.
 - 2. Base per unit quantities.
 - 3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted.
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics.
 - 5. Typical calculations and tabulations of calculated quantities.
 - 6. Results, conclusions, and recommendations.

- C. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 1. Electric utility's supply termination point.
 2. Incoming switchgear.
 3. Unit substation primary and secondary terminals.
 4. Low voltage switchgear.
 5. Motor control centers.
 6. Standby generators and automatic transfer switches.
 7. Branch circuit panelboards.
 8. Other significant locations throughout the system.
- D. On grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- E. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to short circuit ratings.
 2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses.
 3. Adequacy of transformer windings to withstand short-circuit stresses.
 4. Cable and busway sizes for ability to withstand short-circuit heating.
 5. Notify Owner in writing, of existing circuit protective devices improperly rated for the calculated available fault current.

2.02 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the curve sheets, where applicable:
 1. Electric utility's protective device
 2. Medium voltage equipment relays
 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
 6. Conductor damage curves
 7. Ground fault protective devices, as applicable
 8. Pertinent motor starting characteristics and motor damage points
 9. Pertinent generator short-circuit decrement curve and generator damage point
 10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.03 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- D. The Arc-Flash Hazard Analysis shall include all medium voltage and 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.
- E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.04 REPORT SECTIONS

- A. Input Data:
 - 1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
 - 2. Short-circuit reactance of rotating machines with associated X/R ratios
 - 3. Cable type, construction, size, # per phase, length, impedance and conduit type
 - 4. Bus duct type, size, length, and impedance
 - 5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
 - 6. Reactor inductance and continuous ampere rating
 - 7. Aerial line type, construction, conductor spacing, size, # per phase, and length
- B. Short-Circuit Data:
 - 1. Source fault impedance and generator contributions
 - 2. X to R ratios
 - 3. Asymmetry factors

4. Motor contributions
 5. Short circuit kVA
 6. Symmetrical and asymmetrical fault currents
- C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
 - a. Current transformer ratio.
 - b. Current setting.
 - c. Time setting.
 - d. Instantaneous setting.
 - e. Specialty non-overcurrent device settings.
 - f. Recommendations on improved relaying systems, if applicable.
 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground).
 - b. Adjustable time-current characteristic.
 - c. Adjustable instantaneous pickup.
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations.
1. Arcing fault magnitude
 2. Device clearing time
 3. Duration of arc
 4. Arc flash boundary
 5. Working distance
 6. Incident energy
 7. Hazard Risk Category
 8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.01 ARC FLASH WARNING LABELS

- A. The CONTRACTOR shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
 1. Location designation
 2. Nominal voltage
 3. Flash protection boundary
 4. Hazard risk category
 5. Incident energy
 6. Working distance
 7. Engineering report number, revision number and issue date
- C. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided.

2. For each motor control center, two arc flash label shall be provided, one at each end of the motor control center.
 3. For each low voltage switchboard, one arc flash label shall be provided
 4. For each switchgear or unit substations, two arc flash label shall be provided, one at each end of the equipment or near each main breaker.
 5. For each medium voltage switch, one arc flash label shall be provided.
- D. Labels shall be field installed by the electrical supplier performing the studies, local power company, or engineering service division of the equipment manufacturer during the Startup and Acceptance Testing.

3.02 ARC FLASH TRAINING

- A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION

SECTION 16060 - GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical grounding and bonding Work as follows:
 - 1. Solidly grounded.

- B. Applications of electrical grounding and bonding Work in this Section:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Metal building frames.
 - 4. Electrical power systems.
 - 5. Grounding electrodes.
 - 6. Raceways.
 - 7. Service equipment.
 - 8. Enclosures.
 - 9. Equipment.
 - 10. Lighting standards.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.
 - 2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

A. Materials and Components:

1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.
2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
3. Service Arrester: Electrical service arrester, 480 volts, 3-phase, 4-wire, for interior mounting.
4. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 10 feet.
5. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. Connect grounding conductors to underground grounding electrodes using mechanical compression type connectors.
- B. Ground electrical service system neutral at service entrance equipment to grounding electrodes.
- C. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.
- D. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
- E. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.
- F. Connect grounding electrode conductors to 1-inch diameter or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.
- G. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 4/0 AWG bare copper grounding cable.
- H. Bond bare No. 4/0 AWG grounding cable in duct banks to grounding cable in vaults and to power equipment ground bus at ends of each duct bank.

- I. Bond strut and other metal inside of electrical manholes and vaults to bare No. 4/0 AWG grounding cable carried in duct bank.
- J. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.
- K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- L. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.
- M. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.
- N. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.

3.02 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester using the 3-point fall of potential method. Testing shall be performed during normal dry weather conditions with at least 5 non-rain days elapsing prior to test. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms or less by driving additional ground rods; then retest to demonstrate compliance.

END OF SECTION

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SECTION 16070 - SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.
 - h. Unistrut Diversified Products.
 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney.
 - i. Producto Electric Corp.
 - j. Raco, Inc.
 - k. Red Seal Electric Corp.
 - l. Spring City Electrical Mfg. Co.
 - m. Thomas & Betts Corp.

2.02 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors, in NEMA 4 areas, or embedded in concrete shall be hot-dip galvanized.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners. Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: Steel springhead type.
 - 3. Hanger Rods: 0.375-inch diameter minimum, steel.
- C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 12 gauge or 0.105-inch-thick steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

- A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gauge.
 - b. 4-inch to 6-inch: 16-gauge.
 - c. Over 6-inch: 14-gauge.
 - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION

NOT USED

END OF SECTION

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SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
1. Buried electrical line warnings.
 2. Identification labeling for cables and conductors.
 3. Warning and caution signs.
 4. Equipment labels and signs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: Flexible acrylic bands sized to suit raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- B. Underground Line Marking Tape: Permanent, bright colored, continuous printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.
- D. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.
- E. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face and punched for mechanical fasteners.
- F. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

- G. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.
- H. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- I. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.
- B. Underground Electrical Line Identification: During trench backfilling for exterior nonconcrete encased underground power, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench, do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct buried and in raceway.
- D. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system following OWNER's method of phase identification or as follows:

<u>Phase</u>	<u>480/277 Volts</u>
A	Yellow
B	Brown
C	Orange
Neutral	White
Ground	Green

- E. Use conductors with color factory applied entire length of conductors except as follows:
 - 1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

- b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

- F. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.

- G. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

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SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Low-Voltage Wire and Cable.
 - 2. Instrument Cable.
 - 3. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.
- B. Reports of field tests prepared as noted in Section 01600.

1.03 QUALITY ASSURANCE

- A. UL Compliance: Provide components which are listed and labeled by UL. For cables intended for use in air handling space comply with applicable requirements of UL Standard 710, "Test Method for Fire and Smoke characteristics of cables used in Air Handling Spaces."
- B. NEMA/ICEA Compliance: Provide components which comply with following standards:
 - 1. NEMA WC 70-1999/ICEA S-95-658-1999, Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
- C. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.
- D. Network Wiring Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- E. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.
- F. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least

4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.

- G. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Low-Voltage Wire and Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. The Okonite Co.
 - d. Southwire Co.
 - 2. Connectors for Low-Voltage Wires and Cable Conductors:
 - a. AMP.
 - b. O-Z/Gedney Co.
 - c. Square D Company.
 - d. 3M Company.
 - 3. Instrument Cable:
 - a. Belden (Trade Nos. 1120A and 1118A).
 - 4. Local Area Network Cable:
 - a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

- A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable.
- B. Conductor Material: Copper. Minimum size power wire shall be No. 12 AWG.
- C. Insulation: Provide RHW/USE insulation for power conductors used in duct banks. Provide THHN/THWN insulation for power conductors used in single- and 3-phase circuits indoors.
 - 1. Provide XHHW insulation for grounding conductors installed in raceways.
 - 2. Provide THHN/THWN insulation for control conductors.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

- A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 INSTRUMENT CABLE

- A. Instrument Cable: 600 volt minimum insulated shielded cable with two or more twisted No. 16 or No. 18AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding.

2.05 LOCAL AREA NETWORK CABLE

- A. Category 6 (Ethernet) Data and Patch Cable:
 - 1. Paired, 4-pair, 24 AWG, solid bare copper conductors with polyethylene insulation, overall aluminum foil-polyester tape shield with 24 AWG stranded tinned copper drain wire, 100 percent shield coverage, PVC jacket.
 - 2. UL verified to Category 6.
 - 3. Provide plenum rated cable where installed exposed.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to ENGINEER. Test reports shall include ambient temperature and humidity at time of testing. Notify ENGINEER 48 hours prior to test with schedule.
- B. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by CONTRACTOR with at least 5 years of experience in testing Network cabling systems.
 - 1. TESTING: CONTRACTOR shall test each network cable segment. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing.** If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER.
 - 2. DOCUMENTATION (Network Cable): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
 - b. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.

- c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
 - 3. ACCEPTANCE: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and receipt of documentation.
- C. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to ENGINEER.

END OF SECTION

SECTION 16130 - RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Raceways for electrical wiring. Types of raceways in this Section include the following:
1. Intermediate metal conduit.
 2. Liquidtight flexible conduit.
 3. Rigid metal conduit.
 4. Rigid nonmetallic conduit.
 5. PVC externally coated rigid metal conduit.
 6. Conduit bodies.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for the following products:
 - a. Wireway and fittings.
 - b. Conduit.
 - c. Conduit bodies.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 2. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in Work include:
1. Conduit:
 - a. Allied Tube.
 - b. Carlon.
 - c. General Electric Co.
 - d. Johns Manville.
 - e. Occidental Coatings.
 - f. Orangeburg.
 - g. Perma-Cote Industries.
 - h. Republic Steel.

- i. Robroy Industries.
- j. Steelduct Co.
- k. Triangle Conduit.
- l. Wheatland Tube.
- m. Youngstown Sheet and Tube.
- 2. Liquidtight Conduit:
 - a. Anamet, Inc.
 - b. Carlon.
 - c. Electric-Flex.
 - d. Thomas and Betts.
- 3. Conduit Bodies:
 - a. Adalet-PLM.
 - b. American Electric.
 - c. Appleton Electric Co.
 - d. Carlon.
 - e. Crouse-Hinds Division, Cooper Industries, Inc.
 - f. Delta Industrial Products.
 - g. Killark Electric Mfg. Co.
 - h. Kraloy Products Co.
 - i. O-Z/Gedney Co.
 - j. Perma-Cote Industries.
 - k. Robroy Industries.
 - l. Spring City Electrical Mfg. Co.
- 4. Conduit Thread Paint:
 - a. CRC Chemicals, USA.
 - b. Sherwin Williams.
 - c. ZRC Chemical Products Co.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Metal Conduit: ANSI C 80.1, hot-dip galvanized.
- B. Intermediate Metal Conduit: UL 1242, hot-dip galvanized.
- C. PVC Externally Coated Rigid Metal Conduit and Fittings: ANSI C 80.1 and NEMA RN 1, Type 40, 40 mil nominal coating and thickness. The bond of the PVC to the substrate shall be stronger than the tensile strength of the PVC.
- D. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

2.03 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
- C. Underground PVC: NEMA TC 6, Type I for encased burial in concrete, Type II for direct burial.

D. PVC: NEMA TC 9; match to duct type and material.

2.04 CONDUIT BODIES

- A. Provide matching gasketed covers secured with corrosion-resistant screws. Use cast covers in NEMA 4 areas and stamped steel covers in NEMA 1 and 12 areas. Use nonmetallic covers in NEMA 4X areas and threaded, ground joint covers in NEMA 7 and NEMA 9 areas.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies as follows:
1. Rigid Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.
 2. Intermediate Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.
 3. PVC Externally Coated Rigid Metal Conduit: Use hot-dipped galvanized or cadmium-plated cast or malleable iron conduit bodies with threaded hubs factory PVC-coated. Field application of PVC coating to conduit bodies is not acceptable. Secure covers using PVC encapsulated or stainless steel screws.
- C. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.
- D. NEMA 7 and NEMA 9 Areas: Use materials conforming to UL standards for the area.

PART 3 - EXECUTION

NOT USED

END OF SECTION

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SECTION 16135 - CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:
1. Outlet and device boxes.
 2. Pull and junction boxes.
 3. Bushings.
 4. Locknuts.
 5. Conduit hubs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop-fabricated, (nonstock items). For shop-fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.
 2. Product data for boxes, fittings, cabinets, and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
 2. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Outlet Boxes, Concealed Conduit System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Bell Electric, Square D Company
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.

- h. RACO Div., Harvey Hubbell, Inc.
- i. Thomas & Betts Co.
- 2. Outlet Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 3. Device Boxes, Concealed Conduit Systems:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric; Emerson Electric Co.
 - c. Bell Electric, Square D Company.
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co.
- 4. Device Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 5. Junction and Pull Boxes, Concealed System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Bell Electric, Square D Company.
 - e. GTE Corporation.
 - f. Keystone Columbia, Inc.
 - g. OZ/Gedney Co.; General Signal Co.
 - h. Spring City Electrical Mfg. Co.
- 6. Junction and Pull Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 7. Bushings, Knockout Closures, Locknuts, and Connectors:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. AMP, Inc.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Appleton Electric Co., Emerson Electric Co.
 - e. Bell Electric; Square D Co.
 - f. Midland-Ross Corp.
 - g. Midwest Electric, Cooper Industries, Inc.
 - h. OZ/Gedney Co., General Signal Co.
 - i. RACO Div., Harvey Hubbell, Inc.
 - j. Thomas & Betts Co., Inc.

2.02 CABINETS, BOXES, AND FITTINGS - GENERAL

- A. Outlet Boxes: Suitable for the conduit system installation as follows:
1. Exposed Conduit: Provide cast or malleable iron, zinc electroplated outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 4 areas and stamped steel covers for NEMA 12 and undesignated areas.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide the appropriate explosion-proof rating for outlet boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes where PVC-coated conduit is specified.
 2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide cast metal outlet boxes for exterior outlets.
- B. Device Boxes: Suitable for the conduit system as follows:
1. Exposed Conduit: Provide cast or malleable iron, zinc electroplated device boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs on device boxes.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide appropriate explosion-proof rating for device boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated device boxes where PVC-coated conduit is specified.
 2. Concealed Conduit: Provide galvanized coated flat-rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Provide cast metal device boxes for exterior devices.
- C. Junction and Pull Boxes: Suitable for the conduit system installation as follows:
1. Exposed Conduit: For pull and junction boxes 50 cubic inches and smaller, provide cast or malleable iron, zinc electroplated boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs and cast covers with neoprene gaskets. For pull and junction boxes larger than 50 cubic inches provide watertight sheet metal boxes. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. Provide code-gauge sheet steel construction for boxes smaller than 1,000 cubic inches. Provide 0.10-inch steel construction, hot-dip galvanized after fabrication for boxes larger than 1,000 cubic inches. Secure box covers using No. 8 or larger machine screws spaced at intervals not exceeding 6 inches. Provide a continuous neoprene or rubber gasket cemented to the box cover where it contacts the box body.
 - a. Exceptions: Provide nonmetallic pull and junction boxes in NEMA 4X areas. Provide appropriate explosion-proof construction for boxes located in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes for areas where PVC conduit is used.
 2. Concealed Conduit: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.

- D. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications. Provide watertight hubs on conduits terminated at sheet steel enclosures in NEMA 4 areas.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
1. Receptacles.
 2. Ground fault circuit interrupter receptacles.
 3. Snap switches.
 4. Wall plates.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Bryant Electric Co., Division of Hubbell Corporation.
 2. Cooper Wiring Devices.
 3. Hubbell, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Pass and Seymour, Inc.

2.02 WIRING DEVICES

- A. Provide devices which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Provide ivory color devices and wall plates except as otherwise indicated.
- B. Receptacles: Provide specification grade or heavy-duty grounding receptacles with the NEMA rating shown on Wiring Device Schedule on Drawings. Comply with UL 498 and NEMA WD1.
- C. Ground Fault Interrupter (GFI) Receptacles: Provide specification grade or heavy-duty "feed-through" type ground fault circuit interrupter, with integral grounding type NEMA 5-20R duplex receptacles arranged to protect connected downstream receptacles on same circuit. Provide units rated Class A, Group 1, per UL Standard 94.3.

- D. Snap Switches: Provide quiet type specification grade or heavy-duty AC switches rated 20A at 120/277 volts AC. Provide single pole, 2-pole, 3-way or 4-way switches as indicated. Comply with UL 20 and NEMA WD1.

2.03 WIRING DEVICE ACCESSORIES

- A. Wall plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated. Exterior receptacle covers shall provide rainproof protection while in use. Conform to requirements of Section 16075. Provide plates possessing the following additional construction features:
 - 1. NEMA 12 and Unclassified Areas. Material and Finish: 0.04-inch-thick stainless steel, or 0.04-inch-thick brass, chrome plated.
 - 2. NEMA 4 Area Material and Finish: Cast screw cap and cover plate for receptacles. Cast cover plate with lever or plunger operator for switches.
 - 3. NEMA 4X Material and Finish: Non-metallic, watertight wall plates 0.05-inch-thick aluminum, anodized.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16220 - MOTORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section applies, in general, to all electric or DC motor-driven equipment provided under Divisions 2 through 16 Sections. This Section shall supplement the detailed Equipment Specifications, but in cases of conflict, the Specifications indicated in this Section shall govern.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submittals for motors shall accompany the specific equipment the motor is to be supplied with.
 - 2. Submit product literature for each motor.
 - 3. Certification of motor bearing vibration testing.
 - 4. Certificate of compatibility with variable frequency drives.
 - 5. Other certified standard commercial test reports.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01781, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment, and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label, shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by CONTRACTOR.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, motors shall be standard design and construction. Manufacturers offering products which may be incorporated in Work include:
 - 1. Motors:
 - a. Marathon Blue Chip Series.
 - b. Siemens, Inc.
 - c. General Electric Co.
 - d. Reliance Electric Co.
 - e. U.S. Electric Motors.

- B. For motors that are integrally constructed as a piece of equipment, such as appliances, hand tools, etc., and where manufacturer would be required to redesign equipment to meet these general specifications, it is the intent to allow such standard motors to be used, provided they do not exceed 1-1/2 horsepower and are suitable for use on standard power systems.

2.02 MATERIALS

- A. Shop primers shall be Tnemec "77 Chem-Prime," or equal.
- B. Rust preventive compound shall be equal to Dearborn Chemical "No-Ox-ID2W," Houghton "Rust Veto 344," or Rust-Oleum "R-9".

2.03 MANUFACTURED UNITS

- A. Electrical Motors: Motor design and application shall comply with current ANSI, IEEE, NEMA, and AFBMA standards and with the NEC where applicable. They shall be squirrel cage induction motors rated 60 hertz, continuous duty for use in 40 degrees C ambient temperature. Motors shall comply with NEMA MG1-2014 Part 31, Definite Purpose Inverter-Fed Motors whether used with variable frequency drives or not.
 - 1. The motors shall be sized within their rated loads under the specified conditions without utilizing the top 15 percent of the 1.15 service factor. Motor sizing measured at the motor output shaft shall include all loadings on the motor. Motor loadings shall include the maximum or specified load condition of the driven equipment plus all drive losses of components, located between the motor and the driven equipment.
 - 2. The motor winding temperature rise shall be NEMA Standard for the class of insulation used at the rated service factor load.
 - 3. Bearings shall be regreasable, double-shielded, antifriction ball bearings suitable for radial and thrust loading.
 - 4. The motors shall be capable of handling unfiltered voltage peaks of up to 1600 volts, and rise times of 0.1 micro-seconds.
- B. Motors 50 horsepower and larger shall have embedded passive temperature switches in the windings for use in the motor control circuit that will limit the winding temperature as defined by NEMA Standard MG1-12.53 Type 1. The contact shall be normally closed and rated to operate a 120 volt AC control relay (40 VA).
- C. All integral horsepower motors shall have oversize conduit boxes with clamp-type grounding terminals inside which are effectively connected to all noncurrent-carrying motor parts.
- D. Unless these general specifications are supplanted by the detailed equipment specifications, motors shall be rated and constructed as follows:
 - 1. Below 1/2 Horsepower: Motors shall be rated 115/230 volts, single phase, but shall be suitable for use on 208 volt power system. They shall have permanently lubricated sealed bearings (antifriction type where high radial or axial thrusts are produced by the driven equipment). Standard motors shall be totally enclosed fan cooled, totally enclosed air-over, or totally enclosed nonventilated capacitor start type as shown on Equipment Schedule(s) or specified in the equipment specifications. Totally enclosed explosion-proof motors shall be provided where required per equipment specifications section.
 - 2. From 1/2 to 1-1/2 Horsepower: Motors shall be rated 115/230 volts single phase or shall be rated 230/460 volts 3-phase as indicated by Equipment Schedule(s). In either case they shall be

- suitable for use on 208 volt power systems under their given load conditions. They shall have bearings as in 2.03 F.1. The standard enclosures shall be totally enclosed fan cooled, totally enclosed nonventilated, totally enclosed explosion-proof, or open drip-proof as shown on Equipment Schedule(s) or specified in the equipment specifications.
3. From 2 to 200 Horsepower: Motors shall be rated 230/460 or 460 volt, 3-phase. They shall be grease lubricated, ball bearing, Class B insulated, minimum or as specified. Horizontal motors shall be open drip-proof, totally enclosed fan-cooled or totally enclosed explosion-proof (NEC, Class I, Group D) as shown on Equipment Schedule(s) or specified in the equipment specifications. Vertical motors shall meet NEMA standard open drip-proof specifications as a vertical motor when called for or totally enclosed fan cooled or totally enclosed explosion-proof as shown on Equipment Schedule(s).
- E. Horizontal and vertical motors may also be weather protected, Type II, and shall have encapsulated or sealed windings.
 - F. Open drip-proof type motors shall have encapsulated or sealed windings when called for on Drawings or Equipment Schedules.
 - G. Special duty and severe environment application shall have motors which are designed specifically to meet the special conditions as specified.
 - H. The following symbols will be employed on Equipment Schedule(s) to indicate the required motor enclosure and construction features:
 1. TEFC Totally Enclosed Fan-cooled.
 2. ODP Open Drip-proof.
 3. WPII Weather Protected Type II.
 4. E/S Encapsulated or Sealed Windings.
 - a. All motors with encapsulation or sealed windings shall have a water-tight conduit box.
 - I. Well Pump Motor (three):
 1. Motors: Comply with Section 16220, Motors.
 2. General
 - a. Standards: NEMA, IEEE, ANSI, AFBMA
 - b. Comply with Division 16.
 3. Construction
 - a. Type: Weather protected type II construction
 - b. Frame: Heavy fabricated steel or cast iron. Provide largest frame size for motor provided.
 - c. Leads: Shall be brought out to a terminal box enclosed in a NEMA 4X accessory box.
 - d. Shaft: High-grade machine steel or steel forging of size and vertical hollow shaft adequate to withstand all load stresses. Contractor shall coordinate with pump manufacturer prior to bid to verify a seamless connection between motor and pump. No change orders will be issued to rectify a motor/pump mismatch.
 - e. Stators: Random wound.
 - f. Rotor squirrel cage: Cast-aluminum or copper alloy box type construction with brazed end rings.
 - g. Bearings: Grease lubricated anti-friction type with an AFBMA average L-10 life of 100,000 hours. Provide with high thrust bearings. Coordinate bearing thrust requirements with the pump manufacturer's requirements.
 - h. Fasteners: All fittings, bolts, nuts and screws shall be plated to resist corrosion.
 - i. Terminal Box: NEMA-4X (oversized)

- j. NEMA 4X Accessory Box
 - k. VPI 1000 Insulation system (impregnated)
 - l. Stainless Steel Hardware
 - m. Grounding Lug
 - n. The motors shall have the following: Provide non-reverse backstop ratchet design to prevent reversing of the motor.
 - o. Provide with shaft ground rings. The rings shall be Aegis SGR units or approved equal
4. Performance
- a. Rating: 460 Volts, 3 phase, 60 hertz
 - b. Service Factor: 1.15 minimum
 - c. Load: Non-overloading over the entire operating range of the pump curve, exclusive of the service factor.
 - d. Horsepower: 200 hp
 - e. Efficiency: Premium Efficiency, inverter duty.
 - f. Factory Tests: Certified test results of test curves of motor performance each for the tests listed below shall be furnished to the ENGINEER for review prior to shipment of motors (short commercial test – NEMA MG1-12.51)
 - 1) No load current
 - 2) Winding resistance
 - 3) High potential dielectric tests
 - 4) Bearing Inspection
5. Pump motors shall be provided with thermostats.

J. See NEMA Standard MG1 for definition of above terms.

K. Motor Efficiency: Where Equipment Schedule(s) indicate that motors shall be designed for high efficiency, they shall meet or exceed the Motor Operating Characteristics shown on High Efficiency Motor Schedule No. 16220.2, appended to this Section. Guaranteed minimum efficiency at full load shall be based on IEEE Standard 112, Test Method B. Nominal motor efficiencies are average expected values. Manufacturer's motor Shop Drawings shall indicate full compliance with the High Efficiency Motor Schedule No. 16220.2.

2.04 FABRICATION

A. Electric motors shall be shop-finished with 2 coats of enamel paint per manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's written installation and alignment instructions.
- B. Lubricate oil-lubricated bearings.
- C. Provide electrical wiring and connections as specified in Division 16 Sections.

3.02 FIELD QUALITY CONTROL

- A. Inspect all terminations for proper connection.
- B. Check motor for proper rotation.

3.03 INSTALLATION CHECK

- A. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600. Equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and equipment installation and operation is satisfactory to ENGINEER.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Inspection Report: A written report of the installation check shall be submitted to ENGINEER. The report shall be as noted under Section 01600 certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is in accurate alignment;
 - 3. Is free from any undue stress imposed by any connection or anchor bolts;
 - 4. Has been operated under full and partial load conditions and that it operated satisfactorily to ENGINEER; and
 - 5. That OWNER's representative has been instructed in the proper maintenance and operation of the equipment.
 - 6. Furnish OWNER a copy of all test data recorded during the installation check including noise level and vibration readings.

HIGH EFFICIENCY MOTOR SCHEDULE NO. 16220.2
MOTOR OPERATING CHARACTERISTICS

HP	RPM Syn.	Efficiency (percent)						
		Guar. Min.		Nominal			Power Factor (percent)	
		Full	1/2	3/4	Full	1/2	3/4	Full
1	1800	81.5	78.1	81.0	81.5	54.2	67.3	75.8
	1200	75.5	69.5	75.6	78.5	38.4	49.4	58.3
1.5	3600	78.5	78.4	80.2	81.5	75.3	84.4	88.8
	1800	81.5	79.2	82.9	84.0	52.1	65.1	74.0
	1200	81.5	80.5	83.4	84.0	44.0	56.6	85.6
2	3600	81.5	78.8	82.9	84.0	66.3	78.4	85.0
	1800	81.5	78.8	82.6	84.0	48.9	61.7	70.0
	1200	84.0	83.0	83.6	86.5	46.6	59.6	68.0
3	3600	84.0	75.4	84.3	86.5	69.7	80.0	85.6
	1800	86.5	86.9	88.5	88.5	62.3	73.9	79.9
	1200	86.5	84.5	87.5	88.5	45.9	58.3	68.0
5	3600	86.5	86.2	88.2	88.5	71.7	81.7	86.4
	1800	88.5	84.0	88.2	88.5	68.5	79.2	84.6
	1200	86.5	85.8	88.2	88.5	50.8	63.8	71.9
7.5	3600	86.5	82.9	86.7	88.5	75.9	84.3	88.1
	1800	88.5	89.2	90.3	90.2	66.5	77.2	82.4
	1200	86.5	87.5	88.8	88.5	58.6	68.8	73.7
10	3600	86.5	87.7	89.0	88.5	77.1	84.5	87.6
	1800	88.5	89.3	90.4	90.2	67.6	77.4	81.9
	1200	88.5	89.0	90.3	90.2	60.1	70.2	74.9
15	3600	88.5	82.3	87.4	90.2	81.1	87.2	90.4
	1800	90.2	91.0	91.9	91.7	68.5	78.1	82.3
	1200	88.5	89.9	90.6	90.2	67.4	77.1	81.4
20	3600	90.2	89.1	91.1	91.7	83.7	88.5	90.5
	1800	90.2	90.9	91.9	91.7	68.9	78.1	81.8
	1200	90.2	91.0	91.0	91.7	69.8	78.5	81.9
25	3600	90.2	91.6	92.0	91.7	81.9	88.6	90.6
	1800	91.7	92.8	93.2	92.4	72.7	81.4	84.5
	1200	90.2	90.0	91.4	91.7	79.8	84.5	85.5
30	3600	90.2	90.6	91.7	91.7	81.1	87.8	90.3
	1800	91.7	92.8	93.3	93.0	71.5	80.6	84.2
	1200	90.2	91.7	92.0	91.7	78.9	85.4	86.8
40	3600	90.2	89.1	91.2	91.7	83.8	88.6	89.9
	1800	91.7	91.0	92.6	93.0	71.6	80.6	84.2
	1200	91.7	93.0	93.3	93.0	80.9	86.4	88.0
50	3600	90.2	88.7	90.8	91.7	82.5	90.8	92.0
	1800	93.0	92.4	93.7	94.1	76.4	83.7	86.3
	1200	91.7	93.0	93.3	93.0	80.9	87.3	88.9
60	3600	91.7	89.9	92.0	93.0	84.9	89.9	91.6
	1800	93.0	93.2	94.0	94.1	76.3	84.0	86.8
	1200	91.7	92.5	93.1	93.0	75.8	82.9	85.5
75	3600	93.0	91.0	93.1	94.1	82.6	88.7	90.9
	1800	93.0	92.6	93.8	94.1	76.4	83.8	86.6
	1200	93.0	93.5	94.2	94.1	75.1	82.4	84.7
100	3600	93.0	91.3	93.3	94.1	86.1	89.7	91.0
	1800	94.1	93.8	94.8	95.0	83.8	87.6	89.0
	1200	93.0	93.1	93.9	94.1	72.5	80.0	83.2
125	3600	93.0	91.2	93.1	94.1	83.0	88.3	89.0
	1800	93.7	93.5	94.6	95.0	79.2	84.6	86.0
	1200	93.0	93.5	94.2	94.1	75.2	82.3	85.2
150	3600	93.0	91.8	93.4	94.1	85.3	89.3	89.1
	1800	94.1	93.7	94.7	95.0	81.6	86.4	86.6
	1200	94.1	94.1	94.9	95.0	77.2	84.4	85.7
200	3600	94.1	92.7	94.3	95.0	83.3	87.5	88.5
	1800	94.5	94.2	94.9	95.0	80.0	85.6	86.7
	1200	94.3	94.2	94.9	95.0	78.0	84.5	86.0
250	3600	94.3	94.8	95.5	95.3	83.0	87.5	88.5
	1800	94.3	96.0	96.0	95.8	79.5	85.6	83.0

END OF SECTION

SECTION 16231 - STANDBY NATURAL GAS GENERATOR SETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of natural gas generator set Work as indicated by Drawings and Schedules, and is hereby defined to include, but not by way of limitation:
1. Natural gas engine.
 2. Electrical generator.
 3. Engine starting system, including batteries, instrument control panel, protective housing, annunciator panel, exhaust silencer, wall thimble, and accessories.
- B. Types of generator sets required for the Project include:
1. Permanent natural gas engine-driven generator.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data: Submit manufacturer's data on natural gas engine-driven generator sets and components.
 - a. Generator dimensions.
 - b. Generator weight.
 - c. Generator rating.
 - d. Alternator rating.
 - e. Generator starting system data:
 - 1) Battery size and ratings.
 - 2) Charging system capacity.
 - 3) Battery heater data.
 - 4) Battery warranty.
 - f. Generator control panel data:
 - 1) Layout.
 - 2) Wiring diagrams.
 - 3) Control interconnection.
 - 4) Instrumentation.
 - g. Exhaust system data:
 - 1) Muffler size.
 - 2) Decibel reduction curve.
 - 3) Fuel system data.
 - h. Cooling system data:
 - 1) Radiator capacity.
 - 2) Cooling reduction capacity.
 - i. Enclosure data:
 - 1) Materials.
 - 2) Size.
 - 3) Assembly/disassembly instructions.

- 4) Door locations.
- 5) Noise reduction.
- j. Warranty data.
- k. Accessory and miscellaneous equipment.
- 2. Wiring Diagrams: Submit wiring diagrams for natural gas engine-driven generator units showing connections to electrical power panels, feeders, and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.
- 3. Agreement to Maintain: Prior to time of final acceptance, Installer shall submit 4 copies of an agreement for continued service and maintenance of natural gas engine-driven generator sets for OWNER's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for 1-year period with option for renewal of Agreement by OWNER.
- 4. Certifications: Provide natural gas engine-driven generator sets certified test record of the following final production testing:
 - a. Single-step load pickup.
 - b. Transient and steady state governing.
 - c. Safety shutdown device testing.
 - d. Voltage regulation.
 - e. Rated power.
 - f. Maximum power.
 - g. Provide certified test record prior to engine-driven generator set being shipped from factory to Project location.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

- 1. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines," NFPA 99, "Standard for Health Care Facilities," and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures."
- 2. UL Compliance: UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors;" UL 2200, "Standard for Safety for Stationary Engine Generator Assemblies," rated 600 volts or less.
- 3. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG1, "Motors and Generators," and MG2, "Safety and Use of Electric Motors and Generators."
- 4. IEEE Compliance: Comply with applicable portions of IEEE Standard 446, "IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications."

- B. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section. Unit shall be provided with a full factory warranty of 2 years from date of ENGINEER's acceptance.

1.04 SPARE PARTS

A. Provide the following spare parts for each unit provided.

- 1. Oil Filter: Provide one (1) set of oil filter for the break-in oil change and one (1) set of oil filters for second oil change.
- 2. Engine Oil: Provide oil required for break-in oil change and second oil change.
- 3. Intake Air Filter: Provide one (1) set of intake air filters.
- 4. Belts: One (1) spare belt for each belt on the generator package.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which shall be incorporated in Work include:
 - 1. Standby Natural Gas Generator Sets:
 - a. Cummins (BASE BID)
 - b. Kohler Co. (ALTERNATE)

2.02 GENERATOR SETS

- A. Except as otherwise indicated, provide manufacturer's standard natural gas engine-driven generator set and auxiliary equipment as indicated by published product information and as required for a complete installation. Generator set shall be rated to continuously power the total accumulated load and starting load shown on Schedule at 100 degrees F ambient temperature and at altitude where installed.
- B. Natural Gas Engine: Provide a 4-cycle, spark ignition type engine for operation on a commercial grade of natural gas such as that furnished by DTE Energy. Engine operating speed shall not exceed 1,800 rpm and shall be controlled by a governor to maintain alternator frequency within plus or minus 3 hertz of 60 hertz from no load to full load. Frequency shall recover to steady-state tolerance within 5 seconds after application of 90 percent rated load.
- C. Starting System: Provide engine-generator unit with 12 volt negative ground starting system, including positive engagement solenoid shift-starting motor, batteries, and 35 ampere or greater automatic battery charging alternator with solid-state voltage regulator. Mount batteries in a plastic- or epoxy-coated metal platform near the starter but not on the generator, and coat battery terminals with an anti-oxidant. Generator sets rated 150 kW or less shall have a battery rated 650 amperes cold cranking at 0 degree F and 170 minutes reserve capacity by SAE Standard J-537. Larger generators shall have a battery rated either 220 ampere-hours or 900 amperes cold cranking and 430 minutes reserve capacity. Batteries shall have a 12-month full warranty and 60-month prorated warranty.
- D. Battery Charger: Provide a solid-state current limiting, float-type battery charger with 5 ampere minimum capacity. Charger shall operate from 120 volt AC single phase, 60 hertz power and shall automatically keep batteries at full charge. Equip charger with ammeter and voltmeter.
- E. Alternator: Provide a single bearing, brushless, self-excited alternator with inherently regulated rotating rectifier exciter system or a revolving field design with a temperature compensated solid-state voltage regulator. Connect the alternator housing directly to the engine flywheel housing. Couple the alternator rotor directly to engine flywheel with a semi-flexible steel disk coupling.
 - 1. Provide windings with Class F insulation with epoxy impregnation and fungus-resistant coating. Temperature rise shall be as defined in NEMA Standard MG1-22.40.
 - 2. The alternator shall be capable of starting load given on Schedule with 35 percent maximum instantaneous voltage dip. Recovery to stable equation within plus or minus 5 percent of rated voltage shall occur within 3 seconds.
- F. Engine Cooling Radiator: Provide a complete engine cooling system equipped with a radiator and blower type fan sized to maintain safe operation, 190 degrees F engine outlet water temperature at

100 degrees F maximum ambient temperature. The engine cooling system shall be filled with a solution of 50 percent ethylene glycol. On indoor mounted units, radiator shall be equipped with a duct adapter flange. An air duct with flexible connecting sections shall be provided between radiator duct flange and exhaust damper. Provide access to fill and drain ports for ease of maintenance.

G. Generator Set Alarm and Status Display

1. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
 - The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for function, color, and control action (status, warning, or shutdown).
 - The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
 - The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - The control shall include an amber common warning indication lamp
2. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:
 - low oil pressure (alarm)
 - low oil pressure (shutdown)
 - oil pressure sender failure (alarm)
 - low coolant temperature (alarm)
 - high coolant temperature (alarm)
 - high coolant temperature (shutdown)
 - high oil temperature (warning)
 - engine temperature sender failure (alarm)
 - low coolant level (alarm or shutdown--selectable)
 - fail to crank (shutdown)
 - fail to start/overcrank (shutdown)
 - overspeed (shutdown)
 - low DC voltage (alarm)
 - high DC voltage (alarm)
 - weak battery (alarm)
 - low fuel-daytank (alarm)
 - high AC voltage (shutdown)
 - low AC voltage (shutdown)
 - under frequency (shutdown)
 - over current (warning)
 - over current (shutdown)
 - short circuit (shutdown)
 - over load (alarm)
 - emergency stop (shutdown)
 - high bearing temperature (warning)

3. Provisions shall be made for indication of four customer specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
 4. The control shutdown fault conditions shall be configurable for fault bypass
 5. Provide remote monitoring panel that will display the alarms/warnings above along with the power variables of the generator. These variables shall include the following at a minimum:
 - Power Factor
 - Amperage
 - KW
 - Frequency
 - Voltage
 - Total hours in operation
- H. Engine Status Monitoring
1. The following information shall be available from a digital status panel on the generator set control:
 - engine oil pressure (psi or kPA)
 - engine coolant temperature (degrees F or C)
 - engine oil temperature (degrees F or C)
 - engine speed (rpm)
 - number of hours of operation (hours)
 - number of start attempts
 - battery voltage (DC volts)
- I. Instrument Control Panel: Provide engine-generator unit with engine oil pressure and water temperature indicators, reset circuit breaker, static voltage regulator, voltage-adjusting rheostat, voltmeter, ammeter with phase selector switch with OFF position, and running time indicator and frequency meters. Select circuitry of plug-in design, capable of quick replacement and accepting a plug-in device which allows maintenance to test control panel performance without operating the engine.
1. Provide a cranking limiter to open starting circuit in 45 to 90 seconds if engine has not started within that time, or after a series of 3 or more cranking intervals separated by 2 or more rest periods.
 2. Provide engine safety devices to shut unit down on high engine temperature, low oil pressure, overspeed, and overcrank. Provide for each of these conditions, an alarm light and unpowered, normally open contact for remote use. Provide an audible alarm with silence switch which is activated by any alarm condition.
 3. Provide a relay with 2 normally-open and 2 normally-closed contacts rated 5A at 120 volts AC and which is energized when unit is running. Wire these contacts to terminal strips for remote use.
 4. Provide a relay with 2 normally-open and 2 normally-closed contacts rated 5A at 120 volts AC and which is energized when unit is in Fault condition. Wire these contacts to terminal strips for remote use.
 5. Provide a RUN-OFF-AUTO switch. In AUTO position, unit shall start when a remote contact closes and stop when contact opens. In RUN position, unit shall start and run until OFF position is selected.
 6. Mount instrument control panel on unit such that it is isolated from generator set vibration.

2.03 PERMANENT ENGINE-GENERATOR SET ACCESSORIES

- A. Fuel System: Provide unit with all necessary fuel supply lines. Fuel lines shall be furnished pre-assembled to unit. Fuel shut-off valve shall be closed when the engine is not running. Provide flexible connections at engine for all gas lines.
- B. Coolant Heater: Provide an engine coolant heater of voltage indicated on Schedule, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements of NFPA 99.
- C. Inlet and Exhaust Systems: Silencers and exhaust ducting to silencers shall be self-supporting when assembled. Provide all necessary supporting members for ductwork between silencer and outlet. Provide all required cutting as shown on Drawings and noted herein. The unit shall be complete with raincap. All exhaust ducts shall be Schedule 10 304 stainless steel pipe minimum. Inlet silencer and filter to be self-supporting. Provide necessary supports for all intake ductwork. All intake ducts shall be Schedule 10 steel pipe minimum.
 - 1. Provide bellows sections, insulated wall thimbles, and inlet and outlet flexible section as shown on Drawings. Design of exhaust silencer and stack including all ducting shown shall have a pressure drop not exceeding 5 inches of water.
 - 2. Provide a silencer which meets sound standards of a critical area. Silencer shall provide attenuation (input to output) of 39 dB or greater at frequencies of 125 hertz to 8 kilohertz. A curve shall be submitted with Shop Drawings showing attenuation (input to output) in dB versus frequency. Curve shall be on manufacturer's standard data sheet or from an independent test lab. The silencer shall be a slim line space saving design equal to GT EXHAUST Model 501-C2-6100. The silencer shall comprise of a 2 inch compressed thermal/acoustical fiberglass packed shell. The overall silencer height shall be limited to 15 inches and overall length of 65 inches. A spiral or bellows-type flexible section of pipe shall be installed in the exhaust line between the muffler and engine manifold connection. An insulated thimble section shall be provided where exhaust line passes through roof or wall. Exhaust lines shall be pitched and a condensation trap provided at nondraining low points in line.
- D. Paralleling Controller: an integral controller to the generator control panel/breaker compartment shall be provided to allow for multiple generators to provide standby power to the well site. The controller shall completely control and monitor the generator as required for paralleling. There shall be a communication link between this controller and future generator controllers to provide the interconnection between units. Refer to section 16239 for more clarification.
- E. Circuit Breaker: A generator power circuit breaker shall be installed as a manual load circuit interrupter and an automatic overload and short circuit protection device.
 - 1. The circuit breaker shall be a solid-state trip type for all sizes rated 300 amp continuous and larger. Solid-state trip shall include Long-time, Short time, and Instantaneous. Ground fault trip required on breakers 1,000 amps and above.
 - 2. Trip settings for all breakers shall be selected for the rating of the generator power circuit as indicated on Drawings or on Schedule.
- F. Engine Oil Drain: Extend the oil pan drain to extend to the edge of the housekeeping pad. Provide valve on drain line and minimum of 24" of high temperature rubber hose. The hose and valve shall be rated for engine oil and standard operating temperatures of the oil system.

- G. Engine Drip Pan: Provide a stainless steel drip pan below the engine. The sides of the drip pan shall be minimum of 2” high and shall extend to the 3” beyond the engine. Provide a drain port on the side of the drip pan with pipe and valve that extend to the edge of the housekeeping pad. Any support or other penetration through the drip pan shall have a silicon sealant installed between the support or penetration when installed.

PART 3 - EXECUTION

3.01 INSTALLATION OF NATURAL GAS ENGINE-DRIVEN GENERATOR SETS

- A. Install natural gas engine-driven generator units as indicated, in accordance with equipment manufacturer's written instructions and recognized industry practices to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.
- B. Coordinate with other work, including raceways, electrical boxes and fittings, fuel tanks, piping, and accessories, as necessary to interface installation of engine-generator equipment work with other work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B and the National Electrical Code.
- D. Install units on steel spring type vibration isolators fastened to an inertia base in accordance with manufacturer's instructions.
- E. Connect fuel piping to generator equipment as indicated, and comply with manufacturer's installation instructions.
- F. Install the exhaust silencer and exhaust piping. Allow for insulation of the exhaust system per specification 15088 – “HVAC Piping Insulation.”
- G. Install the engine oil drain system and drip pan. Any penetration of the drip pan shall be sealed with sealant during the installation of the device at the penetration.
- H. Provide basic operating instructions laminated and mounted on the generator at the control panel location.

3.02 GROUNDING

- A. Provide equipment grounding connections for natural gas engine-driven generator units as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to ensure permanent and effective grounding.

3.03 FIELD QUALITY CONTROL

A. Start-up Testing:

1. Engage local equipment manufacturer's representative to perform start-up and building load tests upon completion of installation, with ENGINEER in attendance; provide certified test record. Tests are to include the following:
 - a. Check gas pressure, gas supply volume, lubricating oil, and antifreeze in liquid-cooled models for conformity to manufacturer's recommendations under environmental conditions present.
 - b. Test prior to cranking engine for proper operation, accessories that normally function while the set is in a standby mode. Accessories include: engine heaters, battery charger, generator strip heater, remote annunciator.
 - c. Check, during start-up test mode, for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
 - d. Test, by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shutdown. Prior to this test, adjust for proper system coordination, transfer switch timers. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
 - 1) A starting load test is to be performed after installation. Voltage dip will be observed with a recording oscilloscope furnished by supplier for this test only. Voltage dip is defined as the peak-to-peak voltage minimum, at starting compared to the average peak-to-peak voltage with the starting load running. The difference shall be less than 35 percent of the running P-P voltage.
 - 2) Test shall be 2 hours in duration, minimum.
 - e. Upon completion of installation, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to OWNER.

3.04 PERSONNEL TRAINING

- #### A. Building Operating Personnel Training: Train OWNER's building personnel in procedures for starting-up, testing, and operating natural gas engine-driven generator sets. In addition, train OWNER's personnel in periodic maintenance of batteries. Training requirements are specified in Section 01820.

PERMANENT ENGINE-GENERATOR SCHEDULE

Load at starting: 30kVA transformer (65% loaded), and Two 15 kVA transformers (45% loaded each)

Load applied after the above

Starting load is running: One 200 HP Soft Start 300% current limit motor

Voltage Starting Type: 480VAC

<u>Accessories</u>	<u>Required</u>	<u>Remarks</u>
Engine Cooling Radiator	Yes	
Coolant Heater	120VAC	volts
Enclosure	None	
Sound Attenuation	Exhaust Silencer	
Fuel System	Natural Gas	

Minimum Generator Size: 350 kW*

*Stated minimum does not release CONTRACTOR from successfully completing the load test.

END OF SECTION

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SECTION 16238 - TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of transfer switches required for the Project and include the following:
1. Automatic transfer.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data: Submit manufacturer's data and installation instructions for electrical power transfer switches.
 2. Wiring Diagrams: Submit wiring diagrams for electrical transfer switches, and associated control diagrams showing connections to prime and alternate power sources, electrical load, and equipment components. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches," and UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide transfer switches and components which are UL listed and labeled.
 2. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/Nos. ICS 2, "Industrial Control Devices, Controllers and Assemblies," ICS 6 and 250, pertaining to transfer switches.
 3. NFPA Compliance: Comply with applicable requirements of NFPA 99, "Standard for Health Care Facilities," and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures," pertaining to transfer switches.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Automatic Transfer Switches:
 - a. Automatic Switch Co. (ASCO).

2.02 AUTOMATIC TRANSFER SWITCHES

- A. Automatic Transfer Switch: UL listed and 600 volt-rated with amperage rating shown on Drawings and shall be the mechanically held, electrically operated type rated for continuous duty in an unventilated sheet metal enclosure, NEMA 12.

- B. Switch shall be double throw, with an off position, having electrical operated normal-emergency positions inherently interlocked mechanically, and with main contacts mechanically attached to a common shaft. Main contacts shall be silver alloy wiping-action type. They shall be protected by arcing contacts.
- C. Switch and Relay Contacts, Coils, Springs, and Control Elements: Removable from front of transfer switch without removal of the switch panels from enclosure and without disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous duty industrial control type with 600 volt, 10 amp rated contacts.
- D. Upon drop in normal voltage of 83-85 percent of rated voltage, and after an override delay of 3 seconds nominal, switch shall start generator and transfer the load to emergency source, provided emergency source voltage and frequency are 90 percent of rated or higher.
- E. Upon return of normal source voltage for 5 seconds nominal, to 92-95 percent of rated, switch shall retransfer load to normal source after a minimum transfer time or if emergency source fails. Provide a 5- to 60-second adjustable time delay to maintain transfer switch in the "Off" position during transfer to either source.
- F. Sensing relays shall operate without contact chatter or false response when voltage is slowly varied to dropout and pickup levels.
- G. Auxiliary contacts shall be provided: Three N.O. contacts for transfer switch position indicating use (Source 1, 2, and Bypass), one N.O. contact for Fault, and two auxiliary contacts, one N.O. and one N.C. to operate after completion of the 3-second override delay for starting generator. All auxiliary contacts shall be 600 volt, 10 amp continuous rating.
- H. Accessory devices shall be provided as follows:
 - 1. Time delay to override harmless power dips and outages. (Inverse time characteristic with voltage.)
 - 2. Test switch.
 - 3. Auxiliary contacts (as specified herein).
 - 4. Selector relay (as specified herein).
 - 5. Lockout relay (sensitive to voltage and frequency).
 - 6. Full phase protection with nominal 75-80 percent dropout and 92-95 percent pickup on phase relay.
 - 7. Adjustable time delay on retransfer to normal source. Minimum retransfer of 2 minutes and maximum of 25 minutes. Built-in circuitry to nullify the retransfer time delay if the emergency source fails and the normal source is available.
 - 8. Adjustable (10-20 minutes) time delay for running generator unloaded after transfer for cool down.
 - 9. Adjustable time delay or delays (5 to 60 seconds) for holding transfer switch in the "Off" position when switching from standby source to normal and normal source to standby.

10. Engine starting contact.
 11. Exerciser to exercise generator for operator set time periods (ex. 15 minutes every 168 hours).
A selector switch shall permit generator to be exercised with or without load.
- I. Bypass-Isolation Switches: Provide factory-fabricated, manually operated, bypass-isolation switches and auxiliary equipment of types, sizes, ratings, and electrical characteristics for services indicated; used in conjunction with automatic transfer switch to provide a means of directly connecting load conductors to a power source and isolating the automatic transfer switch. Select switches with 2-way bypass to emergency source and capable of functioning as an independent manual transfer switch. In addition, design bypass switch with an intermediate position to permit electrical operation and testing of automatic transfer switch without affecting power to critical load. Provide capability for total electrical isolation of automatic transfer switch for maintenance, testing, and repair. Equip 3-pole drawout-type switches with gang-operated externally operated handle mechanism arranged for padlocking in open position with 1 to 3 padlocks. Provide free standing 14-gauge welded steel NEMA Type 12 enclosure. Coat enclosure with manufacturer's standard color acrylic enamel finish over a corrosion-resisting primer. Color to match automatic transfer switch.

PART 3 - EXECUTION

3.01 PERSONNEL TRAINING

- A. Building Operating Personnel Training: Train OWNER's building personnel in procedures for starting-up, testing, and operating the automatic transfer switch and bypass. In addition, train OWNER's personnel in periodic maintenance. Additional training requirements are specified in Section 01820. Start-up, commissioning and testing are specified in Section 01810.

END OF SECTION

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SECTION 16239 – GENERATOR SET PARALLELING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide complete new factory assembled paralleling equipment with digital electronic controls designed for fast, reliable operation and including the functions described herein.
- B. The generator set manufacturer shall supply and warrant the paralleling equipment to provide a single source of responsibility for all the products provided. Warranty documents shall be provided verifying this warranty. Technicians specifically trained to support the product and employed by the generator set supplier shall service the paralleling equipment. Submit names, qualifications, and locations of individuals who will service and support the equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data and installation instructions for electrical power transfer switches.
 - 2. Wiring Diagrams: Submit wiring diagrams for electrical transfer switches, and associated control diagrams showing connections to prime and alternate power sources, electrical load, and equipment components. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches," and UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide transfer switches and components which are UL listed and labeled.
 - 2. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/Nos. ICS 2, "Industrial Control Devices, Controllers and Assemblies," ICS 6 and 250, pertaining to transfer switches.
 - 3. NFPA Compliance: Comply with applicable requirements of NFPA 99, "Standard for Health Care Facilities," and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures," pertaining to transfer switches.
- B. Equipment provided shall conform to the requirements of the following codes and standards to the extent that they are applicable:
 - 1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
 - 2. CSA 282, Emergency Electrical Power Supply for Buildings
 - 3. EN55011, Class B Radiated Emissions
 - 4. EN55011, Class B Conducted Emissions
 - 5. EN60947-6-1 Standard for Low-voltage switchgear IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991
 - 6. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
 - 7. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
 - 8. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
 - 9. IEC 1000-4-6 Conducted Field Immunity
 - 10. IEC 1000-4-11 Voltage Dip Immunity

11. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 12. NFPA99 – Essential Electrical Systems for Health Care Facilities
 13. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
 14. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 15. UL891 – Switchboards and Controls. Control equipment provided in switchboard enclosures shall be listed and labeled under this standard.
- C. The paralleling equipment manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

PART 2 - PRODUCTS

2.01 POWER MOTOR CONTROL CENTER

A. Switchgear Ratings:

1. The paralleling/distribution power switchgear shall be configured as shown on the contract drawings, and rated for operation at voltage and current levels as shown on the contract drawings. It shall contain devices and equipment as shown on the drawings, in addition to meeting the requirements of this section.

B. Construction

1. Note space available and access requirements, and provide equipment that will fit into the space allowed.
2. Refer to specification Sections 16421 for details on mcc construction requirements.
3. Refer to specification Sections 16238 for details for additional automatic transfer switch construction requirements.
4. Refer to specification Sections 16231 for details for Generator construction requirements.
5. Each section of the paralleling system shall be UL listed and labeled, including all covers, barriers, and supports. Breakers and individual control sections shall be isolated from each other by metal or insulating barriers. Barriers shall also be provided between breakers and bus structure.
6. The system bus shall be silver plated copper with bolted joints for all three phases, with a full neutral, and a 1/4 x 2 inch ground bus extending through all sections and shall not exceed 1000 amps/square inch. Bus shall be braced for peak symmetrical amperage available from all generator sets plus motor contributions and shall be rated 65,000 amps RMS, minimum. (See contract drawings for bus ratings.)
7. The framework and all other sheet metal components of the system shall be primed with a rust-inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel.
8. MCC wiring shall be composed of UL listed, 105 degree centigrade rated material, with all wiring labeled at each end.
9. Power circuit breakers shall be rated for operation at the system voltage, with continuous current rating of as shown on the drawings. Breakers to be operated by an electrically charged, mechanically and electrically trip free stored energy mechanism. Provisions for manual charging of the mechanism and interlocks to prevent withdrawal of the breaker unless it is open shall be included. Breaker shall be 120VAC or line voltage charging, with DC shunt trip system. Where used, the system shall be provided with an individual control power transformer for each paralleling breaker and the generator main (tie), on the generator side of the breaker; and the utility main breaker, on the utility side of the breaker.

10. Current transformers as required for proper system operation, and metering as described herein shall be provided. Current ratios and relay and metering accuracy as required for function of the system. Transformers provided shall have a mechanical rating equal to the momentary rating of the circuit breakers, and insulated for the full voltage rating
 11. Note space available and access requirements for the paralleling equipment, and provide equipment that will fit into the space allowed.
 12. All door mounted control components shall be industrial type oil-tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.
 13. AC control circuits in the switchboard shall be protected with properly sized fuses in safety fuse blocks, with visible fuse blown indication for each fuse. Potential transformers shall be protected on line and load side.
 14. All CT installations shall include shorting type terminal blocks.
- C. The main feeder breakers shall each be provided with metering equipment that is integrated with the HMI provided with the system master control. The metering shall provide 3-phase voltage, amps, hertz, kW, kVar, and kW-hour functions.
- D. Distribution Equipment:
1. Provide feeder distribution breakers of the number and size as shown on the project drawings.
 2. The breakers shall be drawout power circuit breakers of the same manufacturer and model as the paralleling breakers.
 3. The feeder distribution breakers shall be electrically operated and controlled from the system master control panel. Breakers shall be factory wired to provide operation sequence as described in sequence of operation, or as shown on the drawings.

2.02 Control Equipment Construction

- A. Construction
1. Note space available and access requirements for the paralleling equipment, and provide equipment that will fit into the space allowed.
 2. Each section of the paralleling control system shall be listed and labeled under the requirements of UL 891, including all covers, barriers, and supports. Individual control sections shall be isolated from each other by metal or insulating barriers.
 3. All wiring shall be UL listed 105 degree C, 600 volt rated, and sized as required. Each wire, device or function shall be suitably identified by silk-screen or similar permanent identification.
 4. The framework and all other sheet metal components of the system shall be primed with a rust-inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel.
 5. All door mounted control components shall be industrial type oil-tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.
 6. AC control circuits in the switchboard shall be protected with properly sized fuses in safety fuse blocks, with visible fuse blown indication for each fuse. Potential transformers shall be protected on line and load side.
 7. All CT installations shall include shorting type terminal blocks.

8. All field control interconnecting wiring shall be sized as specified by system manufacturer (wiring not designated by the system manufacturer shall be minimum 14 AWG copper). All control interconnect wiring shall be stranded.

B. System Control Power

1. Control power for the paralleling system shall be derived from the generator set 24VDC starting batteries. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. Generator set governing, voltage regulation, load sharing, synchronizing, protection, and control equipment shall be capable of proper operation with battery voltage levels down to 8VDC.
2. Paralleling breaker control power shall be derived from the generator set for charging, opening, and closing the breakers.

2.03 Paralleling Controls. Provide a paralleling control panel for each generator set in the emergency/standby power system. The paralleling control functions shall be integrated with the generator set control functions. Each paralleling control panel shall contain the components and devices as described in this section.

- A. Operator Panel. Each paralleling control panel shall be provided with a panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the following features and capabilities. 1% accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter. Selector switches to allow viewing of voltage and amperes for each phase shall be provided. For 3-phase/4-wire systems the voltmeter shall indicate line to line and line to neutral conditions. Voltmeter and frequency meter shall be analog instruments. Switches and/or other provisions shall be included to allow reading of bus voltage and frequency from this metering set.
- B. Synchroscope and "generator set synchronized" indication. Indication may be synchronizing lamps, LED indication, or other provisions, but must be located on the paralleling control panel, adjacent to the paralleling breaker control switches.
- C. Running Time Meter, Start Counter
- D. Generator Set Mode Selector Switch: Switch shall provide run, off, and automatic functions for control of the generator set. Run mode causes the generator set to immediately start and accelerate to rated speed and voltage, but paralleling breaker does not automatically close. Off mode prevents generator set from starting, or immediately shuts down the generator set if it is running. Auto mode allows genset starting from a remote control system.
- E. Breaker trip/close switch with breaker status indicating lamps. The switch shall be interlocked with the control system such that breaker closure is not possible unless the mode select switch is in the run position and the generator set is synchronized with the system bus.
- F. Control Reset push-button switch with indicating lamp. Lamp shall flash to indicate that generator set is locked out due to a fault condition.
- G. Lamp test push-button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.

- H. The control panel shall be provided with a set of DC-powered lamps with a switch to allow viewing of all functions on the front panel when normal lighting systems are not available.
- I. Emergency Stop switch. The emergency stop switch shall be a red, mushroom head switch that maintains its position until manually reset.
- J. Precision voltage and frequency adjust raise/lower switches. Switches shall allow the generator set frequency and voltage to be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustment switches shall be located adjacent to the generator set and bus metering, breaker control switches, synchroscope and manual paralleling panel, for ease of use by the operator.
- K. Alarm and status indicating panel to indicate the following conditions (alarm horn shall be located on master control):

<u>Function</u>	<u>Lamp Color</u>	<u>Alarm Horn</u>	<u>Shutdown Unit</u>
Low DC Voltage	Amber	*	
High DC Voltage	Amber	*	
Weak Battery	Amber	*	
Fail to Sync	Amber	*	
Low Oil Pressure Alarm	Amber	*	
Low Fuel - daytank	Amber	*	
High Engine Temp Alarm	Amber	*	
Ground Fault	Amber	*	
Overcurrent Alarm	Amber	*	
Breaker Failure	Red	*	*
Breaker Tripped	Red	*	*
Not in Auto	Red	*	*
High Engine Temp	Red	*	*
Low Oil Pressure	Red	*	*
Overcurrent	Red	*	*
Short Circuit	Red	*	*
Loss of Excitation	Red	*	*
Reverse Power	Red	*	*
Overcrank	Red	*	*
Overspeed	Red	*	*
Under Frequency	Red	*	
Under Voltage	Red	*	*
Over Voltage	Red	*	*
Phase Rotation	Red	*	*

Low Coolant Level	Red	*	*
Automatic	Green		
Generator Running	Green		
Breaker Open	Green		
Breaker Closed	Red		
Demand Mode Standby	Green		
Timing for Start	Green		
Timing for Shutdown	Green		

L. Internal Controls. The following internal control components or functions shall be provided for each generator set in the system.

1. Electronic isochronous kW load sharing control to operate the engine governors during synchronizing and to provide isochronous load sharing when paralleled. The control system shall allow sharing of real kW load between all generator sets in the system to within 1% of equal levels, without introduction of frequency droop into the system. The control system shall include all equipment required for kW load sharing with an infinite bus. The infinite bus governing controls shall allow the generator set to synchronize to an infinite bus, parallel, and ramp up to a preset load level on the generator set. Additional controls shall be provided to cause the generator set to ramp up to a kW load level signaled by the system master control PLC. The isochronous load sharing module and engine governor shall be a coordinated system of a single manufacturer.
2. Load demand governing controls shall be provided to cause the generator set to ramp down to zero load when signaled to shut down in a load demand mode. On a signal to re-start, the load demand governing controls shall cause the generator set to synchronize to the system bus, close, and ramp up to its proportional share of the total bus load. The ramp rate of the generator set shall be operator-adjustable.
3. Electronic kVAR load sharing control to operate the alternator excitation system while the generator set is paralleled. The control system shall allow sharing of reactive load between all generator sets in the system to within 1% of equal levels, without introduction of voltage droop into the system. The control system shall include all equipment required for VAR load sharing with an infinite bus in either a constant VAR or constant power factor mode for future application flexibility. (Mode and adjustments selectable by the operator)
4. Equipment shall be provided to monitor the generator set as it is starting, and verify that it has reached at least 90% of nominal voltage and frequency before closing to the bus. The equipment provided shall positively prevent out-of-phase paralleling if two or more engine-generator sets reach operating conditions simultaneously by providing a lockout signal to disable breaker closure for generator set(s) in the system which have not been selected to be the first units to close to the bus. Controls to recognize the failure of the first breaker signaled to close, and allow system operation to proceed in spite of this failure shall also be provided (breaker failure alarm). Systems using dead bus relay schemes without a disable signal to positively prevent out-of-phase paralleling shall not be acceptable under this specification. System shall include an independent backup to automatically operate in the event that the primary system fails.
5. Synchronizer to electronically adjust the engine governor to match the voltage, frequency and phase angle of the bus. Synchronizer shall maintain the engine-generator voltage within 1% of bus voltage and phase angle within 20 electrical degrees of the bus for 0.5 seconds before circuit breaker closing. Each unit shall have its own synchronizer; systems using a switching scheme to utilize a single system synchronizer will not be approved. Synchronizers and systems which utilize a motor driven pot for control of AC voltage during the synchronizing process will not be accepted. The system shall be provided with a fail to synchronize time delay that is adjustable from 10-120

seconds. Control logic for fail to synchronize function shall allow field adjustment of function for either alarm or shutdown of the generator set on failure condition.

6. Controls shall include a permissive relay function to assure that the generator set does not attempt to close out of phase with the bus, due to errant operation of the synchronizer.
7. Controls shall include a permissive (sync check) function, to be used with "generator synchronized" indicator during manual paralleling, to prevent accidental closure of the breaker with the generator set out of phase with the bus. Provisions to allow manual closure of the first generator set to a de-energized bus shall be included.
8. Control equipment shall contain a system of diagnostic LED's to assist in analyzing proper system function.
9. Controls shall include three phase sensing reverse power equipment, to prevent sustained reverse power flow into the generator set. When the reverse power condition exceeds 10% of the generator set kW for 3 seconds, the paralleling circuit breaker shall be tripped open and the generator shut down.
10. Controls shall be provided to verify generator set and bus phase rotation match prior to closing the paralleling breaker.
11. Electronic alternator overcurrent alarm and shutdown protection. This protection is required in addition to the overcurrent trip on the paralleling breaker, and shall sense current flow at the generator set output terminals. The overcurrent alarm shall be indicated when the load current on the generator set is more than 110% of rated current for more than 60 seconds. The overcurrent shutdown shall be matched to the thermal damage curve of the generator set, and shall not have an instantaneous function.
12. Electronic alternator short circuit protection. This protection is in addition to the overcurrent trip on the paralleling breaker. The short circuit shall occur when the load current on the generator set is more than 175% of rated current and an aggregate time/current calculation indicates that the system is approaching the thermal damage point of the alternator. The equipment used shall not have an instantaneous function.
13. Provide overcurrent and short circuit protection for the feeder connecting the generator set to the paralleling switchgear. This protection may be integrated with alternator protection but must be positively coordinated to prevent tripping of the paralleling breaker prior to the operation of the alternator protective equipment.
14. Controls shall be provided to sense loss of excitation of the alternator while paralleled to the system bus.
15. Generator set start contacts rated 10 amps at 32 VDC.
16. Cooldown time delay, adjustable: 0-600 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for shutdown.
17. Start time delay, adjustable: 0-300 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for start.
18. The control system shall monitor the paralleling breaker auxiliary contacts, and initiate a fault signal if the breaker fails to close within an adjustable time delay period after the control has signaled it to close (0.5-15 seconds). Breaker failure alarm shall cause the paralleling breaker to trip open, and lock out until manually reset.
19. Controls shall be provided to initiate an alarm condition when generator set is at 90% of rated frequency for more than 10 seconds.
20. Controls shall be provided to shut down generator set and initiate alarm when the generator set is at less than 85% of nominal voltage for more than 10 seconds, more than 110% of nominal voltage for more than 10 seconds, or more than 130% of nominal.
21. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for reliable system operation, as described herein under "SYSTEM OPERATION".

- M. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for proper and reliable system operation.

PART 3 - OPERATION

3.01 Loss of Normal Power:

- A. System is given signal to start by receipt of start signal from automatic transfer switch. On receipt of this signal, all generator sets automatically and independently start, accelerate to rated frequency and build up to rated voltage. The first start system monitors this process, and on finding a generator set at 90% of rated voltage and frequency, automatically disables all other units from closing to the bus, and closes the ready unit to the bus. At this time the first priority loads close to the bus.
- B. The priority (load add) controls prevent overloading of the system bus by providing control signals to delay operation of designated system loads until sufficient generating capacity is available on the bus, or until the load add override switch on the operator display is actuated.
- C. After the first unit is closed to the bus, the control of the remaining units is switched to the synchronizer in each generator paralleling control, which causes the generator set to synchronize with the system bus, and then close to it at the proper time.
- D. As each unit closes to the bus, the unit assumes its proportional share of the total load on the bus, and the control system will automatically add loads to the generator bus by operating specified priority control devices.
- E. The load control system shall monitor the total capacity of the bus and the load demand for each load step, and automatically add load to the system if sufficient genset capacity is available to serve the load.

3.02 3.02 Failure Of A Unit To Start Or Synchronize:

- A. If a unit fails to start, after the fail to start time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound. The priority control will prevent the lowest priority loads from being added to the system without manual intervention. The priority override controls on the OPERATOR INTERFACE PANEL may be used by an operator to manually add low priority loads to the bus, if he determines that generator capacity is available to serve the loads. Bus overload monitoring shall protect the first priority loads in the event that the bus is inadvertently overloaded due to operator error.
- B. If a unit fails to synchronize, after a preset time delay, an alarm will sound, but the unit will continue to attempt to synchronize until signaled to stop by manual operation of the control switches on the generator set.

3.03 Bus Overload:

- A. If a bus overload occurs for any reason, a load shed signal will be generated to initiate load shedding in the system.
- B. If the bus does not return to proper frequency within a predetermined period of time (adjustable via the OPERATOR INTERFACE PANEL), additional load shed signals will be generated until the generator set bus returns to normal frequency.
- C. Loads that are shed due to overload shall require manual reset via the operator interface panel.

3.04 Load Demand Mode:

- A. When the system running in the emergency mode with the "load demand" switch on the operator interface panel in the "on" position, (After an initial adjustable time delay to allow the system loads to stabilize) controls shall continuously monitor the total load on the bus. If the total load on the bus falls below preset limits for a period of 15 minutes, the controller will automatically shut down generator sets in an operator predetermined order, until the minimum number of generators required to

operate the load remain on the bus. The purpose of this function is to allow the generator sets to operate closer to their rated capacity, thereby decreasing fuel consumption and reducing wear on the system.

- B. On sensing that the available bus capacity is being approached, the standby units will automatically be restarted (in the reverse order of which they were shut down) and paralleled with the bus to assume their proportional share of system load.
- C. The system shall automatically compensate for generator sets of different sizes.

3.05 Return of Normal Power

- A. When normal power has returned, each transfer device shall independently transfer back to the normal source.
- B. When all loads have been transferred back to the utility, and all start signals have been removed from the generator sets, the generator set paralleling breakers shall all open, and the generator sets shall operate at no load for a cooldown period. When the cooldown period has been completed, the generator sets shall shut down.
- C. If a system start signal is received during the cooldown period, one generator set shall immediately close to the system bus and all other units shall synchronize to it, as described in "Loss of Normal Power" above.
- D. Test with Load Mode:
 - 1. The system shall allow the generator sets to be tested by transfer of the system loads to the generator sets. (See transfer system specifications.)
 - 2. Sequence of operation in this mode shall be similar to that described for a power failure condition.
- E. Generator Set Exercise (Test) Without Load Mode
 - 1. The system shall allow testing of the generator sets at no load. In this operation mode the generator sets will start, build up to rated speed and voltage, synchronize and close to the generator bus, but system loads shall not automatically transfer to the generator system. If a power failure occurs during a test period, loads shall immediately close into the system on a priority basis.

PART 4 - OTHER REQUIREMENTS

- 4.01 Factory Testing. The system manufacturer shall perform a complete operational test on the paralleling system (including generator sets, paralleling controls, and power switchgear) prior to shipping from the factory. A certified test report shall be provided, and permanently retained by the system manufacturer
- 4.02 Service and Support
 - A. The manufacturer of the paralleling equipment shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
 - B. The paralleling system, including generator sets and paralleling equipment, shall be serviced by a single local service organization that is trained and factory certified in both generator set and paralleling equipment service. The technicians serving the site shall be specifically trained and certified by the manufacturer in the diagnosis and repair of the synchronizing, paralleling, and load sharing equipment provided. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
 - C. The manufacturer shall maintain model and serial number records for the paralleling equipment for at least 20 years.

END OF SECTION

SECTION 16270 - TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of transformers specified, and include the following:
1. Dry-type transformers (lighting transformers).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data: Submit manufacturer's technical product data, including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data.
 2. Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations.
 3. Wiring Diagrams: Submit wiring diagrams for power distribution transformers.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. NEMA Compliance: Comply with NEMA Standard Pub/Nos. ST 20, "Dry-Type Transformers for General Applications," TR 1, and TR 27.
 2. UL Compliance: Comply with applicable portions of ANSI/UL 506, "Safety Standard for Specialty Transformers. Provide power/distribution transformers and components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Acme Electric Corporation.
 2. General Electric Company.
 3. Hevi-Duty Electric Div., General Signal Corp.
 4. Square D Company.

2.02 POWER/DISTRIBUTION TRANSFORMERS

- A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

- B. Dry-Type Distribution Transformers (45 kVA or less): Provide factory assembled, general purpose, air cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated, K-rated 13 three-phase, 60 hertz, 10 kV BIL, 4.0 percent impedance with 480-volts delta connection primary and 208/120 volts secondary wye connected. Provide primary winding with 4 taps; 2 to 2-1/2 percent increments above and below full-rated voltage for de-energized tap-changing operation. Insulate with Class 150 or 220 degree C insulation and rate for continuous operation at kVA, and limit transformer temperature rise to maximum of 115 or 150 degrees C, respectively. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall mounting.

- C. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16280 - TRANSIENT VOLTAGE SURGE SUPPRESSORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Transient voltage surge suppressors (TVSS) for use on 480 volt, alternating current systems, and motor control center or external mounted applications.

1.02 REFERENCES

- A. Underwriters Laboratories Inc. (UL):
 1. 1449 - High Performance Suppression System.
 2. 1283 - High Frequency Extended Range Power Filter.
- B. American National Standards Institute (ANSI):
 1. C62.41-91 - Category C3 (Service Entrance).
 2. C62.45-91 - Category C Surge.

1.03 SUBMITTALS

- A. Shop Drawings: Include component layout and wiring terminations.
- B. Product data.
- C. Manufacturer's installation instructions.
- D. Operating and maintenance data.
- E. Warranties.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of transient voltage surge suppressor systems for minimum 5 years with satisfactory performance record.
- B. Regulatory Requirements: UL rating of Transient voltage surge suppressor shall meet or exceed UL rating of panelboard, motor control center, or other equipment in which suppressor is installed. UL rating of equipment in which suppressor is installed shall not be affected by suppressor.

1.05 SEQUENCING AND SCHEDULING

- A. Coordinate with and furnish suppressors to motor control center manufacturer prior to shipment of equipment to site.

1.06 WARRANTY

- A. Warrant to correct defective products for minimum 5 years in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 TRANSIENT VOLTAGE SURGE SUPPRESSORS

- A. Ratings: 277/480 volt grounded wye.
- B. Manufacturers: One of the following or equal:
 - 1. Current Technology, Control Guard Model for motor control center installation or Series IND3000 for external mounting.
 - 2. EFI, Titan Series.
 - 3. Leviton, Series 57000.
 - 4. Lighting and Power Control, equivalent product.
 - 5. Advanced Protection Technologies, equivalent product.
- C. Components:
 - 1. 30 ampere fused disconnect.
 - 2. Status indicating pilot lights.
 - 3. Dry contacts.
 - 4. NEMA 1 stab-in housing compatible with motor control center specified in Section 16342.
- D. Characteristics:
 - 1. Single Pulse Surge Current Capacity per Phase: 350,000 amperes.
 - 2. Capacity Per Protection Modes:
 - a. L-N Mode: 175,000 amperes.
 - b. L-G Mode: 175,000 amperes.
 - c. N-G Mode: 175,000 amperes.
 - d. L-L Mode: 175,000 amperes.
 - 3. Surge Life Cycle: 1.2 by 50 micro-seconds 20 kilovolt open circuit voltage, 8/20 micro-second waveform 10 kiloamperes short circuit current Category C3 Bi-wave in accordance with ANSI C62.41 and C62.45.
 - 4. Suppression and Filter Technology: Manufacturer's standard.
 - 5. Continuous Operating Voltage: Minimum 115 percent of nominal.
 - 6. Suppression Voltage In Protective Modes: As follows when tested in accordance with UL 1449:
 - a. For 480 volt systems:
 - 1) L-N: 800
 - b. For 208 volt systems:
 - 1) L-N: 500.
 - 7. EMI/RFI High Frequency Noise Power Filter:

Frequency	100 KHz	1 MHz	10 MHz	100 MHz
Attenuation (dB)	34	51	54	48
Attenuation Ratio	50:1	350:1	500:1	250:1
 - 8. Minimum American Wire Gauge Copper in Surge or Noise Suppression Path: Number 6.
 - 9. Field Replaceable Fusing: Current limiting, protecting each pole.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install suppressors in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 16410 - CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 01600 and 13410, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley.
 - 2. Appleton.
 - 3. Crouse-Hinds Co.
 - 4. General Electric Co.
 - 5. Siemens, Inc.
 - 6. Square D Company.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Provide NEMA 4, 4X, 7, 9, or 12 enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD."
- B. Fusible Switches: (Heavy-duty) switches, with fuses of classes and current ratings indicated. See Section "Fuses" for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- C. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.

2.03 ACCESSORIES

- A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
1. Stainless Steel for NEMA 4 switches.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16420 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of motor controllers, including:

1. Combination controllers.
2. Fractional HP manual controllers.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Shop Drawings: Submit Shop Drawings of motor controllers showing dimensions and sizes.
2. Product Data: Submit manufacturer's data and installation instructions on motor controllers.
3. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components which are UL listed and labeled.
2. NEMA Compliance: Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Allen-Bradley Co.
2. General Electric Co.
3. Siemens, Inc.
4. Square D Company.

2.02 MOTOR CONTROLLERS

A. Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design, and construction in accordance with published product information and as required for a complete installation.

B. Combination Controllers: Consist of controller and circuit breaker or fusible disconnect switch mounted in common enclosure of types, sizes, ratings, and NEMA sizes indicated. Equip starters

with block-type manual reset overload relays. Provide control and pilot devices indicated. Provide 90 degree C SIS or MTW, No. 14 AWG control wiring, tagged at each termination. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with 3 padlocks. Construct and mount controllers and disconnect switches in single NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.

1. The 3-phase starter may be the following types:

a. Full Voltage Non-reversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.

C. Fractional HP Manual Controllers: Provide 3-phase and single-phase fractional horsepower manual motor controllers, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms, and with one-piece melting alloy type thermal units. Controller shall become inoperative when thermal unit is removed. Provide controllers with double-break silver alloy contacts, visible from both sides of controller, and switch capable of being padlocked-OFF. Enclose controller unit in NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16421 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's technical product data on NEMA Class 2, Type B motor control centers (MCCs).
 - 2. Submit layout Drawings of MCCs showing accurately scaled basic equipment sections including, but not limited to, motor starters, controllers, device panels, and circuit breakers. Show spatial relationships of MCC components to proximate electrical equipment. Clearly differentiate on wiring diagrams those conductors which are factory installed and those which are field installed.
 - 3. Fuse and Overload Sizes: Submit a compiled list of motors, fuse sizes, overload sizes, and types for motors actually installed.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include data and parts list for each MCC and troubleshooting maintenance guide.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. NEMA Compliance: Comply with NEMA Standards Pub/No. ICS-2, pertaining to construction, testing, and installation of MCCs, and with applicable NEMA standards for circuit breakers and fuses.
 - 2. UL Compliance: Comply with applicable requirements of UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL Standard 845, "Electric Motor Control Centers." Provide MCCs and ancillary equipment which are UL listed and labeled.
 - 3. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 pertaining to construction and installation of MCCs.
 - 4. ANSI Compliance: Comply with applicable requirements of ANSI as applicable to MCCs.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley Co.
 - 2. General Electric Co.
 - 3. Siemens, Inc.
 - 4. Square D Company.

2.02 MOTOR CONTROL CENTERS AND COMPONENTS

- A. Provide MCCs and ancillary components of sizes, ratings, classes, types, and characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information and as required for complete installation and as specified herein.
- B. MCCs: For operation on power source rating indicated, consisting of one or more vertical sections, each with groupings of control units containing motor starters, thermal overload units, disconnects, and including such other electrical equipment as controls, control transformers, metering panels, current transformers, and auxiliary devices as indicated. Provide MCC with NEMA Class 2, Type B wiring, wire units using 90°C SIS or MTW stranded copper wire; No. 14 AWG minimum. Tag all wires at each termination.
- C. MCC Supporting Structures: Factory assembled, dead-front, MCC standard supporting structures with enclosed vertical sections, fastened together to form rigid freestanding assembly. Construct each section 90 inches high with 9-inch horizontal wireways at top and bottom, 20 inches wide, and with 20-inch section depth for front-of-board unit arrangement. Provide NEMA Type 12 enclosure. Provide gasketing on all enclosing sheet steel, wireways, and unit doors. Construct units with 4-5/8-inch wide, 8-inch deep, 90-inch high vertical wireway in each vertical structure on right side of unit, accessible through hinged doors, and with supports at proper intervals within for fastening wires/cables. Form supporting members of not less than 13 gauge hot-rolled steel. Construct structure doors with removable pin hinges and secure with quarter-turn indicating type fasteners. Provide front-accessible main lug compartment for connection of incoming cables in top or bottom as indicated. Provide removable lifting angle full length of MCC. Design lifting angle to support entire weight of MCC section. Design bottom channels to be removable; provide holes for bolting MCC units to floor.
 - 1. Provide shipping splits in MCC lineup to allow for shipment of maximum 60-inch-long units. Design MCCs so matching vertical sections of same current rating and manufacturer can be added later at either end of lineup without use of transition sections. Provide removable end and top plates to close off openings.
- D. Bus System: Tin-plated aluminum or copper, braced to withstand faults of 65,000 rms symmetrical amperes minimum unless indicated otherwise. Provide main horizontal bus with rating shown, and vertical bus rating of 300 amperes minimum; and construct vertical bus bars with protective barriers to prevent accidental contact of personnel with bus. Vertical bus shall be full length.
 - 1. Provide 0.25-inch by 1-inch minimum copper ground bus running full width of MCC at bottom of lineup. Drill ground bus and furnish 1 lug per starter unit, minimum.
- E. Starter Units: Draw-out type, magnetic motor starters with fusible switch or motor circuit protector type disconnects, auxiliary control devices, and NEMA size as indicated. Construct each starter unit with doors, unit support pans, saddles, and disconnect operators; enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments. Equip with thermal and magnetic overload protection device for each motor circuit, unit-mounted pilot devices, timers, selector switches, indicating lights, and control relays. Provide 1 spare normally open auxiliary contact. Provide draw-out units with de-energized position where unit is still supported by structure, but no electrical connection is made. Provide method of locking unit in de-energized position. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other.

1. Three-phase starter may be following types:
 - a. Full Voltage Nonreversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
- F. Unit Plug-On: Provide plug-on connections for each electrical power phase. Design contact fingers to be floating and self-aligning; silver plate contacts for obtaining low-resistance connections.
- G. Disconnect Operators: Provide external operator handles for switches and circuit breakers. Design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with 3 padlocks.
- H. Unit Doors: Securely mounted with rugged concealed-type hinges which allow doors to swing open minimum of 115 degrees for ease of unit maintenance and withdrawal. Fasten doors to structure so that they remain in place when unit is withdrawn.
 1. Closed door must cover unit space when unit has been temporarily removed. Provide interlock for each unit door with associated disconnect mechanism to prevent door from opening when unit is energized.
- I. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of unit requirements or provide 150VA rated transformer, whichever is greater.
 1. Provide synchronous type timers unless otherwise noted.
 2. Provide 300 volt-rated, oil-tight type pilot lights, push buttons, and selector switches. Equip Start push button with extended guard and black color insert. Equip Stop push buttons with half guard and red color insert.
 3. Provide 120/6 volt transformer type push button to test pilot lights with lens color indicated. Pilot lights shall be LED type.
 4. Provide ice cube type relays, each with 1 spare N.O. contact.
 5. Provide 6-digit elapsed time indicators with 1/10 hour increments.
- J. Circuit Breakers: Factory assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole and with fault-current limiting protection; ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees. Provide with AL/CU rated mechanical screw type removable connector lugs.
- K. Power Monitor: Microprocessor-based device capable of measuring each phase current, line-to-line voltage, line-to-neutral voltage, watts, VARS, power factor, demand watts, and frequency. Unit shall contain kilowatt hour totalizer. 3-CT's and 3 (fused)-PT's shall be provided and factory installed as required. Unit shall have Ethernet TCP/IP communication for interconnection to the PLC system. Coordinate with PLC manufacturer to communication is seamless and does not require a gateway.
- L. Finishes: Thoroughly clean interior and exterior prior to coating of MCC, including bolted joints, with rust-inhibiting prime coat. Provide 2 finish coats of manufacturer's standard color baked-on enamel finish.

- M. Spare Units: In each motor control center, provide a spare Size 2 full voltage, nonreversing combination starter. Provide a Hand-Off Auto switch and red "running" pilot light in this unit.
1. In each motor control center, provide a spare 100 amp and 30 amp circuit breaker.
 2. In each motor control center, provide space for addition of a Size 2 motor starter.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16440 - PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
1. Power distribution panelboards.
 2. Lighting panelboards.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.
 2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
 3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. General Electric Company.
 2. Siemens, Inc.
 3. Square D Company.

2.02 PANELBOARDS

- A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

- B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with tin-plated aluminum, or silver- or tin-plated copper bus bars braced for 50,000 rms symmetrical amperes fault current, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide as indicated, either molded-case bolt-on main and branch circuit breakers for each circuit with toggle handles that indicate when tripped, or bolt-on fusible switches for main and branch circuits. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards.
- C. Lighting Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar with bolt-in type heavy-duty, quick-make quick-break, single pole circuit breakers, and toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Panelboards and circuit breakers shall be braced for 10,000 rms symmetrical amperes fault current unless otherwise indicated.
- D. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.
- E. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.
- F. Ground Fault Protected Breakers: Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles. For breakers dedicated to equipment (sump pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.
- G. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.

- H. Spares: In each panelboard provide 8 installed, single pole, 20A spare circuit breakers unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

- A. Type out panelboard's circuit directory card upon completion of installation Work.

END OF SECTION

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SECTION 16480 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFDs, bypass soft starter, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors originally installed approximately in 1993.

1.02 DEFINITIONS

- A. CPT: Control power transformer.
- B. DDC: Direct digital control.
- C. EMI: Electromagnetic interference.
- D. OCPD: Overcurrent protective device.
- E. PID: Control action, proportional plus integral plus derivative.
- F. RFI: Radio-frequency interference.
- G. VFD: Variable-frequency Drive motor controller.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated.
- B. Shop Drawings: For each VFD indicated.
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Provide recommended spare parts list in with submittal.
 - 4. Installation and Maintenance manuals shall be shipped with the VFD and shall include detailed installation, start-up, and checkout procedures and adjustment and troubleshooting information.
 - 5. Submit evidence that the equipment will be provided with all specified controls, features, options and accessories.
 - 6. Submit certification that the equipment is designed and manufactured in conformance with all applicable codes and standards.
 - 7. Certified copies of test results shall be submitted for all tests specified in this section.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.

- B. Seismic Qualification Bracing: For each VFD, accessories, and components, from manufacturer.
 - 1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 2. Detailed description of equipment anchorage devices to allow for 100 degree tipping of unit.
- C. Product certificates.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data: Provide the following.
 - 1. Five (5) hard copies in 3-ring binders with Table of Contents and Cover Page.
 - 2. One (1) electronic copy; searchable PDF.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
- B. The drives and enclosure shall be assembled, and built by the manufacturer. Drives assembled by the Contractor do not comply with this specification.

1.07 CODES AND STANDARDS

- A. The VFD shall comply with the applicable requirements of the latest standards of ANSI, IEEE, NEMA, the NEC, and be UL/CSA listed.

1.08 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Allen-Bradley
- B. Siemens
- C. Square D Group Schneider

2.02 SYSTEM DESCRIPTION

- A. General Requirements for VFDs:
 - 1. VFDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- B. Application: variable torque.

- C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 - 1. Units suitable for operation of NEMA MG 1 motors.
 - 2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
 - 3. VFD shall be a 6 pulse system
 - 4. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section. Bipolar Junction Transistors, GTOs or SCRs will not be acceptable
 - 5. Provide 3% line reactor and dV/dT output filter.

- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

- E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

- F. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
 - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
 - 3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
 - 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
 - 5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
 - 6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
 - 7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
 - 8. Humidity Rating: Less than 95 percent (noncondensing).
 - 9. Altitude Rating: Not exceeding 3300 feet.
 - 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 - 11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 - 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 - 13. Speed Regulation: Plus or minus 5 percent.
 - 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 - 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
 - 16. Total current harmonic distortion shall not exceed the values in Table 10.3 of IEEE – 519 at the point of connection.
 - 17. Noise: 80 dB or less.

- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

- H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
 - 1. Signal: Electrical.

- I. Internal Adjustability Capabilities:
 - 1. Minimum Speed: 5 to 50 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration: 0.1 to 999.9 seconds.

4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor-overtemperature fault.
- K. Automatic Reset/Restart: Attempt three restarts after VFD fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- M. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction or returning motor to set speed in proper direction, without causing damage to the VFD, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. The entire drive electronics/circuit boards shall be conformal coated.

2.03 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Run.
 2. VFD fault.
 3. High Winding Temp.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (V dc).
 9. Set point frequency (Hz).
 10. Motor output voltage (V ac).
 11. Temperature (Deg F)
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
 - 1) Speed Command
 - b. A minimum of six multifunction programmable digital inputs.
 - 1) Start
 - 2) Stop
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the control system:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 3. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).

4. Output Signal Interface: A minimum of six programmable digital output signal(s), which can be configured for the following:
 - a. Motor Running
 - b. VFD System Alarm
 - c. VFD in bypass (P21W, P741 Only)
 - d. 15 AMP (120/240VAC) rated contact for motor heater
 - e. 15 AMP (120/240VAC) rated contact for seal water solenoid
 - f. Spare

- F. VFD shall be provided with the following communications ports: RS-232 port, USB 2.0 port, and Ethernet/IP. The RS-232 port and the Ethernet/IP port shall be for control communication and not just programming interfaces.
 1. The drive shall communicate to the PLC system directly without the need for gateways or protocol conversion modules.

2.04 BYPASS SYSTEMS (P21W, P741 Only)

- A. Bypass Operation: Transfers motor between power converter output and bypass circuit. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

- B. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller.
 1. Bypass Contactor: Soft Starter.
 2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

- C. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
 1. NORMAL/BYPASS mechanically interlocked relays.
 2. ON/OFF/REMOTE selector switch.
 3. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 4. Control Circuits: 120-Vac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
 5. Overload Relays: NEMA ICS 2.

2.05 ENCLOSURES

- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 1. Type 12. Add protection from circulating dust and dripping/spraying water.

- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

- C. Tilting: Equipment shall be rated to be tipped 100 degrees in all directions during installation. Price shall include cost associated with providing field service technicians for the removal and reinstallation of any components within the enclosure that maybe required to allow the enclosure to be tipped. Warranty shall not be affected by tipping requirements.
- D. Drives shall be constructed such that they can be located back to back. Service of equipment including fans and ventilation filters shall be from the front, or top of the enclosure. No maintenance of parts shall be required from the drive rear.

2.06 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.
 - 1. Push Buttons: Unguarded.
 - 2. Pilot Lights: Push to test, LED.
 - 3. Selector Switches: Rotary type.
- B. NC bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
- F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Filters: VFD manufacturer shall provide sufficient supply and exhaust fan sizing to allow the owner to install furnace-type filters over the air supply openings. The installation of such filters shall not reduce VFD performance nor void any manufacturer warranty

2.07 CONTROL WIRING INSTALLATION

- A. Bundle, train, and support wiring in enclosures.

2.08 IDENTIFICATION

- A. Identify VFDs, components, and control wiring.
 - 1. Label each enclosure-mounted control and pilot device.
 - 2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

2.09 SPARE PARTS

- A. Provide the following:
 - 1. One (1) box of fuses for each type and size used.
 - 2. Two (2) timers of each type used.
 - 3. Six (6) relays of each type used.
 - 4. Two (2) sets of overloads.

2.10 START UP AND COMMISSIONING

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment shall visit Site of Work a minimum of 2 times per VFD. The equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to OWNER.
 - 1. The supplier shall provide a field start-up and calibration service on-Site. The supplier is to perform the calibration at Site at a mutually set time with ENGINEER. ENGINEER is to witness the calibration. The supplier's personnel shall have a stable 4-20 mA source, and a plus or minus 0.5 percent accurate 3-1/2-digit, digital milliamp meter to be used in the calibration procedure. The supplier's personnel must also have an electronic vibration sensor that reads in displacement and velocity to dynamically balance the motor and its driven device over the entire operating speed range. The pump and motor coupled and running under load shall be dynamically balanced after installation. The amplitude of vibration shall be measured on the bearing housings of the motor in all directions with a portable electronic measuring device such as Balance Technology Inc., Model 801, Vitec, Inc., Model 655, Metrix Instrument Co., Model 5282, or equal. The plane and rpm of maximum vibration shall be determined at each bearing and recorded. The frequency of maximum velocity vibration amplitude shall also be determined and recorded for each bearing. The maximum allowable vibration velocity for an acceptable installation shall be 0.3 inch per second. The vibration testing shall be witnessed by ENGINEER. The recorded results shall be submitted to ENGINEER including a sketch showing the plane of maximum vibration.
 - 2. The system will be calibration checked at 100 percent, 75 percent, 50 percent, and minimum speed points. The minimum and maximum speeds will be set. The deceleration and acceleration rates will be set. The delay to restart will be set.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.
- C. Each equipment supplier's representative shall furnish to OWNER a written report certifying that the equipment:
 - 1. Has been properly installed and lubricated;
 - 2. Is balanced and in accurate alignment;
 - 3. Is free from any undue stress imposed by connecting piping or anchor bolts;
 - 4. Has been operated under full load condition and that it operated satisfactorily to OWNER;
 - 5. That OWNER's operators have been instructed in the proper maintenance and operation of the equipment; and
 - 6. Furnish OWNER a copy of all test data recorded during the installation check including noise level and vibration readings.
- D. Furnish training at the well field on the operation and maintenance of the two different drive setups (VFD only, VFD with Bypass) per specification 01820.

2.11 OPERATION AND MAINTENANCE TRAINING

- A. Provide services of manufacturer's service representative to instruct OWNER's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Refer to specification 01820 for further clarification.
 - 1. Manufacturer's representative shall provide in quote two, eight hour days with each day scheduled one week or more apart (scheduling of days shall be determined by Owner).
 - 2. Review operating and maintenance data contained in the operating and maintenance manuals.

END OF SECTION

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SECTION 16510 - LIGHTING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Types of lighting fixtures, including:
 - 1. Solid-state luminaires that use LED technology.
 - 2. Lighting fixture supports.
- B. Applications of lighting fixtures required for this Project include:
 - 1. Interior lighting.
 - 2. Exterior lighting.
 - 3. Emergency lighting.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's product data and installation instructions on each type lighting fixture and component. Assemble in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet. Indicate voltage, bulb type, and wattage.
 - 2. Illumination Data: Provide isofootcandle (isolux) plot diagram of footcandles on horizontal pavement surface which shows values of illuminance projected from indicated fixture heights for roadway and parking area lighting.
- B. Operation and Maintenance Manuals: submit in accordance with Section 01600, operation and maintenance manuals for items included under this Section. Include maintenance data and parts list for each lighting fixture and accessory, and troubleshooting maintenance guide

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/No. LE 2 pertaining lighting equipment.
 - 2. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
 - 3. UL Compliance: Comply with requirements of UL standards, including Standards 486A and B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL listed and labeled.
 - 4. NFPA Compliance: Comply with applicable requirements of NFPA 78, "Lightning Protection Code," pertaining to installation of exterior lighting fixtures.
 - 5. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Lighting Fixtures:
 - a. See Luminaire Schedules on Drawings.
 2. Emergency Lighting:
 - a. Chloride Systems.
 - b. Dual-Lite, Inc.
 - c. Emergi-Lite, Inc.
 - d. Exide, Inc.
 - e. Holophane Lighting.
 - f. Hubbell, Inc.
 - g. Lightalarms Electronics Corp.
 - h. Lithonia Lighting.
 - i. Thomas Industries, Inc.

2.02 EXTERIOR LIGHTING FIXTURES

- A. Provide lighting fixtures of sizes, types, and ratings indicated on Luminaire Schedule on Drawings, complete with, but not limited to, housings, energy efficient ballasts, starters, and wiring.

2.03 INTERIOR LIGHTING FIXTURES

- A. Provide lighting fixtures of sizes, types, and ratings indicated on Luminaire Schedule on Drawings, complete with, but not limited to, housings, energy-efficient lamps, lamp holders, reflectors, energy-efficient ballasts, starters, and wiring. Ship fixtures factory assembled with components required for a complete installation. Design fixtures with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen ballast-generated noise.
- B. LED:
1. 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.
 2. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 3. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 4. Recessed Fixtures: Comply with NEMA LE 4.
 5. CRI of 70. CCT of 3000 K or as indicated on the drawings.
 6. Rated lamp life of 50,000 hours.
 7. Lamps dimmable from 100 percent to 0 percent of maximum light output.
 8. Internal driver.
 9. Nominal Operating Voltage: 120 V ac, 240 V ac, 277 V ac (multi-volt).
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
 10. Housings:
 - a. Extruded-aluminum housing and heat sink.

- 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 relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers 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 otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.

2.04 EMERGENCY LIGHT SET AND EXIT SIGN

- A. Self-contained, surface wall-mounted AC battery-illuminated exit sign unit, universal mounting with 2 lamp heads, and having the following features unless otherwise indicated:
 - 1. Housing: 14-gauge steel or high-impact, injection-molded structural foam or fiberglass reinforced thermoplastic. Provide NEMA enclosure rating suitable for location in which unit is installed.
 - 2. Indicator Light for High Charge Rate and Test Switch: On front panel, with concealed terminals for remote lamp heads.
 - 3. Integral Lamp Heads: Mounted on housing with 180-degree 2-way, locking swivel joints for aiming. Lamps shall be LED type, or as indicated.
 - 4. Battery: Sealed, maintenance-free, lead-acid or calcium type, with 10-year pro rata adjustment warranty or 5-year, no charge replacement warranty.
 - 5. Charger: Minimum 2-rate, fully automatic, solid-state type with sealed transfer relay and fused output circuits.
 - 6. Faceplate: High-impact, UL 94 V-O rated, plastic with snap-out arrows and color of letters as indicated.
 - 7. Finish: Manufacturer's standard for exposed parts, baked enamel on steel.
 - 8. Operation: Exit sign is illuminated by AC-powered lamps under normal conditions. Relay turns emergency sign and lamps on automatically when supply circuit voltage drops to 80 percent of nominal or below. Sign and lamps operate for duration of outage, up to 1.5 hours. Sign and lamps automatically disconnect from battery when voltage approaches deep-discharge value. When normal voltage is restored, AC-powered sign is relighted and DC sign and lamps are switched off. Battery is automatically recharged within 16 hours and maintained on trickle charge.

2.05 EXTRA MATERIALS

- A. Extra Stock: Furnish stock of replacement lamps amounting to 15 percent (but not less than 1 lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to OWNER's storage space and obtain receipt.

PART 3 - EXECUTION

3.01 INSTALLATION OF INTERIOR LIGHTING FIXTURES

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements. Field locate fixtures to avoid conflicts with equipment, pipework, etc.

END OF SECTION

SECTION 16748 - SOFTWARE SERVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, equipment, and services necessary for furnishing fabrication, production, and installation of items specified in this Section or as shown on Drawings.
- B. Work includes programming, testing, and installation of software required for a complete and fully operational well site control system. Principal segments of Work include, but are not limited to, programmable logic controller ladder logic, data collection, and operator process control interfaces.

1.02 SYSTEM DESCRIPTION

- A. Design Requirements. System consists of three well houses with a VFD driven pump in each of the buildings. There is a main control panel located in building 25W. The main panel contains a Programmable Logic Controller (PLC) with processor, with connection to Ethernet Remote I/O racks in the remaining two buildings, 21W and 741. The main panel has a touchscreen interface that allows full control and monitoring of the well field. The main processor is connected to the City SCADA system via an Ethernet radio system. Each well house has instrumentation for temperature, pressure and level. Building 25W also has instrumentation for power monitoring, and generator monitoring. Each VFD has both hardwired control and an Ethernet connection to the PLC network. Contractor shall program the well field PLC system and radios. Contractor shall coordinate with the Owner for the messaging of information to the Water Plant SCADA system. The Owner will be performing the programming at the plant.
- B. Performance Requirements: Programmable logic controllers (PLCs) shall complete execution of all rungs with a cycle time not to exceed 250 mS. Operator interface functions shall have a 2-second response time or better. Adjust timing and operating system parameters of PLCs and computers as necessary.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings and product data for products provided under this Section.

1.04 QUALITY ASSURANCE

- A. Software Progress Meetings: Allow in Bid for 2 meetings per month at the Water Plant in Ann Arbor, Michigan, for review of PLC logic and graphic operator screens. Meeting to commence at time of Contract Award and continue up to panel checkout.
- B. Project progress meetings shall be held at Site or Water Treatment Plant at an interval not to exceed once per month during the software development cycle. Meetings shall be once per week during software installation and field checking phases. Representatives of OWNER and ENGINEER will attend these meetings.

1. These meetings shall be for specific purpose of assuring that software development Work is in accord with Project requirements and are in addition to Project progress meetings that may otherwise be required. Document and distribute to all attendees minutes of meetings.
- C. Discussion Items for these meetings:
1. Sequence of Operations
 2. Functional Intent
 3. Alarm List
 4. Verify ranges, signals, etc.
 5. IP addresses
 6. Color Schemes
 7. Schedules

PART 2 - PRODUCTS

2.01 SERVICE SUPPLIER

- A. Software services shall be fulfilled by the organization selected as "Equipment Supplier" under Section 13410.

2.02 SOFTWARE SERVICES

- A. Software services include program development, testing, documentation, and Work necessary to implement a complete and fully operating system as shown on Drawings and/or as specified. Provide programming to implement required functions and features.
- B. Work requires coordination with concurrent program development for PLCs, Operator Interface, and Data Collection. Include PLC error detection logic for communications failures, data highway faults, internal faults, and time outs. Communicate PLC error conditions to Operator Interface for logging and reporting.
- C. Communication between PLCs, Operator Interface, and Data Collection shall be on an exception basis. When reportable changes in process state occur, such as alarm assertion, return to normal, or analog value out of dead band, report event to PLC that communicates with Operator Interface and Data Collection. This PLC shall maintain data tables current with all process inputs and outputs. Organize data to be transferred into contiguous blocks of information using bit-mapped and integer tables. Employ a "watchdog" timer for each remote PLC and poll that PLC if no message has been received in a reasonable amount of time. Accept Operator Interface directives for setpoint changes and hand switches.
- D. Communication from well field PLC to Plant SCADA via the existing radio system shall be through explicit messaging only. Contractor shall be responsible for the radio system programming required to transmit/receive signals between well field and Plant SCADA system.

2.03 PROGRAMMABLE CONTROLLER LOGIC

- A. Develop programs for execution on PLC using development software supplied for that specific PLC. Logic shall perform functions required to control processes and equipment as shown on Drawings and/or as specified. Develop complete cross-references for ladder logic and complete input/output listings.

B. Process Control Narratives

1. Well Pump with VFD and no Bypass

- a. VFD OOR switch set to Local – pump will run at the VFD HMI set speed.
- b. VFD OOR switch set to Off – Pump will stop if running, and be idle
- c. VFD OOR switch set to Remote – Pump will start and stop from either the touchscreen in building 25W or from a water plant instigated signal. The pump speed will be manually set on the touchscreen or water plant SCADA interface. Pump will have interlocks with high pressure shutoff and low level shutoff.
- d. Monitored Analog Signals:
 - 1) VFD Speed Feedback – depict continuous speed reading, and provide speed mismatch alarm when the difference between the speed control signal and the feedback signal are more than 5% different after an Operator set time period.
 - 2) Well Level – depict continuous level, and provide Operator set low level alarm. Provide Operator set pump shutoff level.
 - 3) Well Discharge Pressure - depict continuous discharge pressure, and provide Operator set high pressure alarm. Provide Operator set pump shutoff pressure.
 - 4) Pump Room Temperature – depict continuous temperature reading, and provide Operator set low and high alarms.
 - 5) Provide trend for analog signals for one day. At the end of the day, the trend will start over.
- e. Monitored Digital Signals to be depicted on the LOI.
 - 1) VFD In Remote
 - 2) VFD Fault
 - 3) Pump Running
 - 4) VFD Ready
 - 5) High Winding Temperature Alarm

2. Well Pump with VFD and Bypass

- a. Bypass/Inverter Selection:
 - 1) Either the Bypass/Inverter push buttons or HMI selection will determine if the pump will operate with VFD or bypass starter.
 - 2) If Inverter is selected, pump will operate as described above.
 - 3) If Bypass is selected,
 - OOR switch set to Local – pump will run at full speed.
 - OOR switch set to Off – Pump will stop if running, and be idle
 - OOR switch set to Remote – Pump will start and stop from either the touchscreen in building 25W or from a water plant instigated signal. There will be no pump speed adjustment on the touchscreen or water plant SCADA interface. Pump will have interlocks with high pressure shutoff and low level shutoff.
- b. Monitored Analog Signals:
 - 1) VFD Speed Feedback (Inverter selected only) – depict continuous speed reading, and provide speed mismatch alarm when the difference between the speed control signal and the feedback signal are more than 5% different after an Operator set time period.
 - 2) Well Level – depict continuous level, and provide Operator set low level alarm. Provide Operator set pump shutoff level.
 - 3) Well Discharge Pressure - depict continuous discharge pressure, and provide Operator set high pressure alarm. Provide Operator set pump shutoff pressure.
 - 4) Pump Room Temperature – depict continuous temperature reading, and provide Operator set low and high alarms.
 - 5) Provide trend for analog signals for one day. At the end of the day, the trend will start over.

- c. Monitored Digital Signals to be depicted on the LOI.
 - 1) Bypass Selected
 - 2) Inverter Selected
 - 3) VFD In Remote
 - 4) VFD Fault
 - 5) Pump Running
 - 6) Pump Ready
 - 7) High Winding Temperature Alarm
 - 8) Bypass Overloads
3. Miscellaneous Systems
 - a. Pump Room Flood Level Float
 - 1) Monitor the fault condition on the LOI and Plant SCADA system.
 - b. Supply Fans
 - 1) Monitor the Running and Fault condition on the LOI and Plant SCADA system.
 - c. Surge Protection Device
 - 1) Monitor the Fault condition on the LOI and Plant SCADA system.
 - d. Generator #1
 - 1) Monitor the Running and Fault condition on the LOI and Plant SCADA system
 - e. Automatic Transfer Switch
 - 1) Monitor the following signals on the LOI and Plant SCADA system:
 - Source 1 (Utility) Selected
 - Source 2 (Generator) Selected
 - Bypass Selected
 - Failure

2.04 OPERATOR INTERFACE AND DATA COLLECTION (PANEL MOUNTED TOUCHSCREEN)

- A. Operator Interface programs provide graphic representation of plant processes and control over machinery. Data collection activities provide historical trend analysis and process data readings for use in management reporting.
- B. Provide following screens:
 1. Well Field overview.
 2. Building 25W overview
 3. Building 21W overview
 4. Building 741 overview
 5. Power Monitoring (includes ATS, SPD, and Generator System)
 6. VFD control screen
 7. Trending
 8. Alarms
 9. Setpoints
 10. Communications
- C. Operator Displays: Develop programs to provide following elements and as required for a complete fully functional Operator Interface and data collection system:
 1. Video displays shall be color at highest resolution supported by hardware. Install operating system drivers as necessary. They shall be fully windowed and shall use a mouse for control. Use colors, function keys, and navigational controls consistently.
 2. Alarm Management: For each process or system event classed as an alarm provide facilities for displaying and logging on system alarm printer, acknowledgment, and purging of stale

messages. Alarm events are derived from discrete inputs, analog trip values, logic combinations and computations as needed. Print and display both alarm events and returns to normal. Provide date/time stamps for events, descriptive message, and event type code. Use color combinations to distinguish following alarm states: Alarm-Unacknowledged, Alarm-Acknowledged, Normal-Unacknowledged, and Normal-Acknowledged.

3. Graphic Displays: Provide process-oriented displays showing current process status and accepting operator input for setpoint and status changes. Submit for approval color schema and screen-to-screen navigation strategies. For each display, show process elements such as pumps, valves, tanks, pipe lines, etc., with their current operational status. Provide analog displays for board instruments shown including indicators, controllers, manual loading stations, etc. Indicators shall use an appropriate number of significant digits and dead band to produce steady values and color to show operational status.
 4. Trending: Provide on-screen trending displays that are user definable that operate from either previously collected historical trend groups (named file) or from a group of real-time variables. Provide facilities for user selection of colors, time (horizontal), and measurement (vertical) scales. Accommodate real-time sampling intervals as short as 1 second. Real-time trends shall show alarm setpoints. Historical trend displays shall have time-scale panning controls.
 5. Security: Using operator interface and operating system software, implement a security system to restrict access to parts of system. Provide following as a minimum:
 - a. Programmer - Access to all facilities including changing displays and logic.
 - b. Supervisor - Access to all displays, change master set points and purge stale alarm messages.
 - c. Operator - Access to all displays, change normal operational sequences and acknowledge alarms.
 - d. Observer - Access to displays only.
- D. Provide following data management functions:
1. Collection files are closed at 00:05 of first day of each calendar month and a new file started. Establish a file naming convention based on file type (analog, historical, or motor), month, and year. Provide operator screens for managing file space:
 - a. Backing up to archive medium.
 - b. Restoration from archive.
 - c. Deleting archive files.
 - d. Display/print of archive catalog.
 - e. Forcing early closure of collection file.
 - f. Create export file.
 2. Analog Points: Scan each analog point every minute. Every hour, store minimum, maximum, and average values in a journal file. Do not store values that are out of range, out of service, or not valid for any other reason.
 3. Historical Trend Data Collection: Establish data collection tables for up to 20 groups of up to 6 process points each with a collection interval of 1 minute. Provide facilities for defining and changing trend groups. Removal and archiving of closed trend files shall be accomplished using operating system's standard backup/restore programs. Do not store values that are out of range, out of service, or not valid for any other reason.
 4. Motor Run Times: For each monitored motor, store daily values for running time. Run times may be developed either by scanning points every minute or by providing PLC timer logic. Daily accumulated run times are to be stored at 00:01 of each day and then reset. Close running time data collection file at 00:05 on first day of each month.

PART 3 - EXECUTION

3.01 SOURCE QUALITY CONTROL

- A. Conduct preliminary testing prior to factory checkout by executing programs supplied for this Project. Use simulated input and output devices as necessary to verify correct interpretation. Exercise inputs to test logic for correct function and proper response of outputs. Verify correct interface of PLC logic with programs used for Operator Interface and Data Collection Activities. Verify correct PLC to PLC communications.

- B. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

ATTACHMENTS

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CITY OF ANN ARBOR
PREVAILING WAGE DECLARATION OF COMPLIANCE

The "wage and employment requirements" of Section 1:320 of Chapter 14 of Title I of the Ann Arbor City Code mandates that the city not enter any contract, understanding or other arrangement for a public improvement for or on behalf of the city unless the contract provides that all craftsmen, mechanics and laborers employed directly on the site in connection with said improvements, including said employees of subcontractors, shall receive the prevailing wage for the corresponding classes of craftsmen, mechanics and laborers, as determined by statistics for the Ann Arbor area compiled by the United States Department of Labor. Where the contract and the Ann Arbor City Code are silent as to definitions of terms required in determining contract compliance with regard to prevailing wages, the definitions provided in the Davis-Bacon Act as amended (40 U.S.C. 278-a to 276-a-7) for the terms shall be used. Further, to the extent that any employees of the contractor providing services under this contract are not part of the class of craftsmen, mechanics and laborers who receive a prevailing wage in conformance with section 1:320 of Chapter 14 of Title I of the Code of the City of Ann Arbor, employees shall be paid a prescribed minimum level of compensation (i.e. Living Wage) for the time those employees perform work on the contract in conformance with section 1:815 of Chapter 23 of Title I of the Code of the City of Ann Arbor.

At the request of the city, any contractor or subcontractor shall provide satisfactory proof of compliance with this provision.

The Contractor agrees:

- (a) To pay each of its employees whose wage level is required to comply with federal, state or local prevailing wage law, for work covered or funded by this contract with the City,
- (b) To require each subcontractor performing work covered or funded by this contract with the City to pay each of its employees the applicable prescribed wage level under the conditions stated in subsection (a) or (b) above.
- (c) To provide to the City payroll records or other documentation within ten (10) business days from the receipt of a request by the City.
- (d) To permit access to work sites to City representatives for the purposes of monitoring compliance, and investigating complaints or non-compliance.

The undersigned states that he/she has the requisite authority to act on behalf of his/her employer in these matters and has offered to provide the services in accordance with the terms of the wage and employment provisions of the Chapter 14 of the Ann Arbor City Code. The undersigned certifies that he/she has read and is familiar with the terms of Section 1:320 of Chapter 14 of the Ann Arbor City Code and by executing this Declaration of Compliance obligates his/her employer and any subcontractor employed by it to perform work on the contract to the wage and employment requirements stated herein. The undersigned further acknowledges and agrees that if it is found to be in violation of the wage and employment requirements of Section 1:320 of the Chapter 14 of the Ann Arbor City Code it shall have been deemed a material breach of the terms of the contract and grounds for termination of same by the City.

Company Name

Signature of Authorized Representative

Date

Print Name and Title

Address, City, State, Zip

Phone/Email address

Questions about this form? Contact Procurement Office City of Ann Arbor Phone: 734/794-6500

CITY OF ANN ARBOR LIVING WAGE ORDINANCE

RATE EFFECTIVE APRIL 30, 2016 - ENDING APRIL 29, 2017

\$12.93 per hour

If the employer provides health care benefits*

\$14.43 per hour

If the employer does **NOT** provide health care benefits*

Employers providing services to or for the City of Ann Arbor or recipients of grants or financial assistance from the City of Ann Arbor for a value of more than \$10,000 in a twelve-month period of time must pay those employees performing work on a City of Ann Arbor contract or grant, the above living wage.

ENFORCEMENT

The City of Ann Arbor may recover back wages either administratively or through court action for the employees that have been underpaid in violation of the law. Persons denied payment of the living wage have the right to bring a civil action for damages in addition to any action taken by the City.

Violation of this Ordinance is punishable by fines of not more than \$500/violation plus costs, with each day being considered a separate violation. Additionally, the City of Ann Arbor has the right to modify, terminate, cancel or suspend a contract in the event of a violation of the Ordinance.

* Health Care benefits include those paid for by the employer or making an employer contribution toward the purchase of health care. The employee contribution must not exceed \$.50 an hour for an average work week; and the employer cost or contribution must equal no less than \$1/hr for the average work week.

The Law Requires Employers to Display This Poster Where Employees Can Readily See It.

**For Additional Information or to File a Complaint Contact:
Colin Spencer at 734/794-6500 or cspencer@a2gov.org**



Vendor Conflict of Interest Disclosure Form

All vendors interested in conducting business with the City of Ann Arbor must complete and return the Vendor Conflict of Interest Disclosure Form in order to be eligible to be awarded a contract. Please note that all vendors are subject to comply with the City of Ann Arbor's conflict interest policies as stated within the certification section below.

If a vendor has a relationship with a City of Ann Arbor official or employee, an immediate family member of a City of Ann Arbor official or employee, the vendor shall disclose the information required below.

Certification: I hereby certify that to my knowledge, there is no conflict of interest involving the vendor named below:

1. No City official or employee or City employee's immediate family member has an ownership interest in vendor's company or is deriving personal financial gain from this contract.
2. No retired or separated City official or employee who has been retired or separated from the City for less than one (1) year has an ownership interest in vendor's Company.
3. No City employee is contemporaneously employed or prospectively to be employed with the vendor.
4. Vendor hereby declares it has not and will not provide gifts or hospitality of any dollar value or any other gratuities to any City employee or elected official to obtain or maintain a contract.
5. Please note any exceptions below:

Vendor Name	Vendor Phone Number
Conflict of Interest Disclosure *	
Name of City of Ann Arbor employees, elected officials, or immediate family members with whom there maybe a potential conflict of interest.	<input type="checkbox"/> Relationship to employee _____ <input type="checkbox"/> Interest in vendor's company _____ <input type="checkbox"/> Other _____

*Disclosing a potential conflict of interest does not disqualify vendors. In the event vendors do not disclose potential conflicts of interest and they are detected by the City, vendor will be exempt from doing business with the City.

I certify that the information provided is true and correct by my signature below:

Signature of Vendor Authorized Representative	Date	Printed Name of Vendor Authorized Representative

PROCUREMENT USE ONLY

- Yes, named employee was involved in Bid / Proposal process.
- No, named employee was not involved in procurement process or decision.

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CITY OF ANN ARBOR NON-DISCRIMINATION ORDINANCE

Relevant provisions of Chapter 112, Nondiscrimination, of the Ann Arbor City Code are included below. You can review the entire ordinance at [www. a2gov.org/departments/city-clerk](http://www.a2gov.org/departments/city-clerk)

Intent: It is the intent of the city that no individual be denied equal protection of the laws; nor shall any individual be denied the enjoyment of his or her civil or political rights or be discriminated against because of actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight.

Discriminatory Employment Practices: No person shall discriminate in the hire, employment, compensation, work classifications, conditions or terms, promotion or demotion, or termination of employment of any individual. No person shall discriminate in limiting membership, conditions of membership or termination of membership in any labor union or apprenticeship program.

Discriminatory Effects: No person shall adopt, enforce or employ any policy or requirement which has the effect of creating unequal opportunities according to actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight for an individual to obtain housing, employment or public accommodation, except for a bona fide business necessity. Such a necessity does not arise due to a mere inconvenience or because of suspected objection to such a person by neighbors, customers or other persons.

Nondiscrimination by City Contractors: All contractors proposing to do business with the City of Ann Arbor shall satisfy the contract compliance administrative policy adopted by the City Administrator in accordance with the guidelines of this section. All city contractors shall ensure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity and tends to eliminate inequality based upon any classification protected by this chapter. All contractors shall agree not to discriminate against an employee or applicant for employment with respect to hire, tenure, terms, conditions, or privileges of employment, or a matter directly or indirectly related to employment, because of any applicable protected classification. All contractors shall be required to post a copy of Ann Arbor's Non-Discrimination Ordinance at all work locations where its employees provide services under a contract with the city.

Complaint Procedure: If any individual has a grievance alleging a violation of this chapter, he/she has 180 calendar days from the date of the individual's knowledge of the allegedly discriminatory action or 180 calendar days from the date when the individual should have known of the alleged discriminatory action to file a complaint with the city's Human Rights Commission. If an individual fails to file a complaint alleging a violation of this chapter within the specified time frame, the complaint will not be considered by the Human Rights Commission. The complaint should be made in writing to the Human Rights Commission. The complaint may be filed in person with the City Clerk, by e-mail at aahumanrightscommission@gmail.com, or by mail (Ann Arbor Human Rights Commission, PO Box 8647, Ann Arbor, MI 48107). The complaint must contain information about the alleged discrimination, such as name, address, phone number of the complainant and location, date and description of the alleged violation of this chapter.

Private Actions For Damages or Injunctive Relief: To the extent allowed by law, an individual who is the victim of discriminatory action in violation of this chapter may bring a civil action for appropriate injunctive relief or damages or both against the person(s) who acted in violation of this chapter

THIS IS AN OFFICIAL GOVERNMENT NOTICE AND
MUST BE DISPLAYED WHERE EMPLOYEES CAN READILY SEE IT.

APPENDIX A

Well House 25W

Asbestos Lead and Regulated Building Materials Survey

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APPENDIX B

Well House 21W

Asbestos Lead and Regulated Building Materials Survey

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APPENDIX C

Well House 741

Asbestos, Lead and Regulated Building Materials Survey

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APPENDIX D

Geotechnical Subsurface Investigation Report

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**Tetra Tech
Ann Arbor, Michigan**

**Geotechnical Subsurface Investigation
Proposed Pre-Engineered Metal Building
Steere Farm at the
Ann Arbor Municipal Airport
Ann Arbor, Michigan**

October 2015





44265 Plymouth Oaks Blvd.
Plymouth, MI 48170
T 734-455-8600
F 734-455-8808
www.tlassoc.com

October 30, 2015

TTL Project No. 13295.01

Mr. Brian M. Rubel, P.E.
Tetra Tech
710 Avis Drive
Ann Arbor, Michigan 48108

**Geotechnical Subsurface Investigation
Proposed Pre-Engineered Metal Building
Steere Farm at the Ann Arbor Municipal Airport
Ann Arbor, Michigan**

Dear Mr. Rubel:

Following is the report of the geotechnical subsurface investigation performed by TTL Associates, Inc. (TTL) at the referenced site. This investigation was performed in general accordance with TTL Proposal No. 13295.01, dated September 4, 2015, and was authorized via a Subconsultant Services Agreement, dated September 11, 2015.

This final report provides information regarding the field and laboratory test data, as well as our engineering interpretations and recommendations for design and construction of new building foundations and floor slabs. Soil samples collected during this investigation will be stored at our laboratory for 90 days from the date of this report. The samples will be discarded after this time unless you request that they be saved or delivered to you.

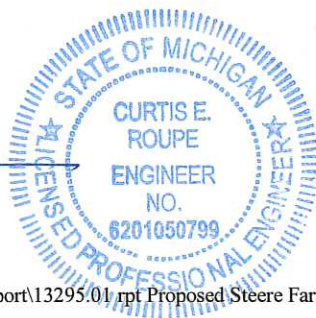
Should you have any questions regarding this report or require additional information, please contact the undersigned at our office.

Sincerely,

TTL Associates, Inc.

Katherine D. Chulski, EIT
Geotechnical Engineer

Curtis E. Roupe, P.E.
Vice President



T:\Geotech\Projects 2015\13295.01...Report\13295.01_rpt Proposed Steere Farm Building Ann Arbor MI.doc

**GEOTECHNICAL SUBSURFACE INVESTIGATION
PROPOSED PRE-ENGINEERED METAL BUILDING
STEERE FARM AT THE ANN ARBOR MUNICIPAL AIRPORT
ANN ARBOR, MICHIGAN**

FOR

**TETRA TECH
710 AVIS DRIVE
ANN ARBOR, MICHIGAN 48108**

SUBMITTED

**OCTOBER 30, 2015
TTL PROJECT NO. 13295.01**

**TTL ASSOCIATES, INC.
44265 PLYMOUTH OAKS BOULEVARD
PLYMOUTH, MICHIGAN 48170
(734) 455-8600
(734) 455-8608 FAX**



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PLATES

- Plate 1.0 Site Location Map
- Plate 2.0 Test Boring Location Plan

FIGURES

- Logs of Test Borings
- Legend Key
- Tabulation of Test Data
- Grain Size Distribution

1.0 INTRODUCTION

This geotechnical subsurface investigation report has been prepared for the construction of a pre-engineered metal building at the Steere Farm at the Ann Arbor Municipal Airport in Ann Arbor, Michigan. The general vicinity of the project is shown on the Site Location Map (Plate 1.0).

This investigation was performed in general accordance with TTL Proposal No. 13295.01, dated September 4, 2015, and was authorized via a Subconsultant Services Agreement, dated September 11, 2015.

The purpose of this investigation was to evaluate the subsurface conditions relative to the design and construction of building foundations and floor slabs at the above referenced site. To accomplish this, three test borings, laboratory soils testing, and a geotechnical engineering evaluation of the test results were performed.

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures, presents the findings, and provides our design and construction recommendations for foundations and floor slabs. The report includes:

- A description of the subsurface soil and groundwater conditions encountered at the boring locations.
- Design recommendations for building foundations and floor slabs related to the proposed development.
- Recommendations concerning soil and groundwater related construction procedures such as site preparation, earthwork, foundation and floor slab construction, and related field testing.

This investigation did not include an environmental assessment of the subsurface materials at the site.

2.0 INVESTIGATIVE PROCEDURES

This subsurface investigation included three test borings, designated Borings B-1, B-2, and B-3, drilled by TTL on October 16, 2015. Boring B-1 was performed in the area of the future generator in the eastern portion of the proposed building. Boring B-2 was performed near the center of the northern face of the proposed building (near the northeast corner of the existing building). Boring B-3 was performed near the southwest corner of the proposed building. The borings were located in the field by TTL in general accordance with the site plan provided by Tetra Tech. The approximate boring locations are shown on the Test Boring Location Plan (Plate 2.0).

The test borings were performed in general accordance with geotechnical investigative procedures outlined in ASTM Standards D 1452 and D 5434. The test borings performed during this investigation were drilled with an ATV-mounted drilling rig utilizing 2¾-inch inside diameter hollow-stem augers. The test borings were terminated at the target completion depth of 20 feet below existing grade.

During auger advancement, soil samples were generally collected at 2½-foot intervals to a depth of 10 feet and at 5-foot intervals thereafter. Split-spoon (SS) samples were obtained by the Standard Penetration Test (SPT) Method (ASTM D 1586), which consists of driving a 2-inch outside diameter split-barrel sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three successive 6-inch increments with the number of blows per increment being recorded. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance (N-value) and is presented on the Logs of Test Borings attached to this report. The samples were sealed in jars and transported to our laboratory for further classification and testing.

A Shelby tube sample, designated ST on the Log of Test Boring, was obtained from Boring B-3 (4 to 6 feet). The Shelby tube sample was obtained by hydraulically advancing a 3-inch diameter, thin-walled sampler approximately 24 inches beyond the hollow-stem auger into undisturbed soil, in accordance with ASTM D 1587. The Shelby tube was then extracted from the subsoils, and the ends were capped and sealed. The sample was transported to our laboratory where it was extruded, classified, and tested.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, groundwater conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

All samples of the subsoils were tested in the laboratory for moisture content (ASTM D 2216), and were visually or manually classified using the Unified Soil Classification System (ASTM D 2487 and D 2488). Dry density determinations and unconfined compressive strength tests by the constant rate of strain method (ASTM D 2166) were performed on the Shelby tube sample and selected intact cohesive split-spoon samples. Unconfined compressive strength estimates were performed on the remaining intact cohesive samples using a calibrated hand penetrometer. An Atterberg limits test (ASTM D 4318) and a particle size analysis (ASTM D 422) were performed on a representative sample from Boring B-2 (SS-2) to determine soil classification and index properties. The results of these tests are presented on the Logs of Test Borings, Tabulation of Test Data sheets, and the Grain Size Distribution sheet attached to this report.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations, especially at previously developed sites such as this site. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.0 PROPOSED CONSTRUCTION

It is our understanding that the project consists of construction of a pre-engineered metal building at the Steere Farm at the Ann Arbor Municipal Airport in Ann Arbor, Michigan. We further understand that the building will be a single-story, slab-on-grade structure, approximately 1,400 square feet in plan. Structural loads were not available at the time of preparing this report but are assumed to be light to moderate in magnitude. Maximum column loads are assumed to be 100 kips and maximum wall loads are assumed to be 2,000 pounds per lineal foot (plf).

Final site grades are assumed to approximate existing site grades.

4.0 GENERAL SITE AND SUBSURFACE CONDITIONS

4.1 General Site Conditions

At the time of this investigation, site grades were generally level. The project site consisted of an existing building with gravel pavements, as well as grassy areas.

The surface materials at Boring B-1 consisted of approximately 8 inches of topsoil. The surface materials at Borings B-2 and B-3 consisted of crushed stone ranging in thickness from approximately 6 to 8 inches.

Underlying the crushed stone in Borings B-2 and B-3, granular existing **fill** materials were encountered to a depth of approximately 3 feet below existing grades. These fill materials consisted of clayey sand with trace crushed stone. SPT N-values ranged from 4 to 8 blows per foot (bpf), indicating **loose** compactness. Moisture contents varied from 8 to 20 percent.

4.2 General Subsurface Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface materials and fill materials generally consisted of a stratum of predominantly sandy soils with interbedded marginal-strength cohesive soils, underlain by a stratum of cohesive soils.

Stratum I consisted of predominantly native granular soils interbedded with marginal-strength cohesive soils underlying the topsoil in Boring B-1, as well as the granular fill materials in Borings B-2 and B-3, to depths ranging from 8½ to 13½ feet.

The encountered Stratum I **granular** soils consisted of silty sand (SM), poorly graded sand with silt (SP/SM) and trace gravel, as well as clayey sand (SC). SPT N-values generally ranged from 4 to 7 bpf indicating **very loose** to **loose** compactness. Moisture contents for these soils generally ranged from 14 to 18 percent.

The encountered Stratum I marginal-strength **cohesive** soils consisted of lean clay (CL) with varying amounts of sand. SPT N-values ranged from 4 to 8 bpf, and unconfined compressive strengths ranged from 500 to 1,995 pounds per square foot (psf), indicating **soft** to medium stiff consistency. Moisture contents for these soils generally ranged from 17 to 26 percent.

Stratum II consisted of stiff to very stiff cohesive soils encountered underlying Stratum I to boring termination at a depth of 20 feet. The Stratum II soils consisted of lean clay (CL) with varying amounts of sand. SPT N-values ranged from 10 to 20 bpf. Unconfined compressive strengths varied from 5,000 psf to greater than 9,000 psf (the highest obtainable reading using a calibrated hand penetrometer). Moisture contents ranged from 12 to 24 percent, generally increasing with depth.

Additional descriptions of the stratigraphy encountered in the borings are presented on the attached Logs of Test Borings.

4.3 Groundwater Conditions

Groundwater was initially encountered during drilling in each boring at depths ranging from 6 to 11 feet. Groundwater was observed upon completion of drilling operations in two of the three borings at depths of 17 feet and 18 feet. Groundwater was not observed upon completion of drilling in Boring B-3. The encountered groundwater conditions are summarized in Table 4.3. It should be noted that the boreholes were drilled and backfilled within the same day, and stabilized water levels may not have occurred over this limited time period. Instrumentation was not installed to observe long-term groundwater levels.

Table 4.3 Encountered Groundwater Conditions		
Boring Number	Depth of Groundwater Initially Encountered During Drilling (feet)	Depth of Groundwater Observed Upon Completion of Drilling (feet)
B-1	6	18
B-2	6	17
B-3	11	N.E.

N.E. – Not Encountered

Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that long-term “normal” groundwater levels at the site will generally be encountered at depths of approximately 6 feet or greater below existing grades. However, it should be noted that groundwater elevations can fluctuate with seasonal and climatic influences. In addition, “perched” water may be encountered within the fill materials or Stratum I granular soils that are underlain by relatively impermeable native cohesive soils. Thus, the groundwater conditions at the site may vary at different times of the year from those encountered during this investigation.

5.0 DESIGN RECOMMENDATIONS

The following conclusions and recommendations are based on our understanding of the proposed construction and the data obtained during our field investigation. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by TTL. These recommendations are subject to satisfactory completion of the recommended site and subgrade preparation and fill placement operations described in Section 6.0, “Construction Recommendations”.

5.1 Building Foundations

Based on the results of the field and laboratory testing for the borings performed for this investigation, the soils encountered at the anticipated foundation bearing depth (3½ feet for protection from frost penetration) are expected to consist of Stratum I interbedded **very loose** to **loose** granular soils and **soft** to medium stiff cohesive soils. Depending on site grading, existing **fill** materials may also be encountered at foundation bearing elevation. The medium stiff or better native cohesive soils as well as the native granular soils are considered generally suitable for support of the proposed building, although the loose granular soils will require in-place modification (recompaction) to provide a suitable bearing stratum and reduce post-construction settlement. Where **soft** cohesive soils or existing **fill** materials are encountered, they will require removal and replacement with new granular engineered fill.

It should be noted that foundation bearing materials may also consist of new engineered fill utilized to achieve design grades after removal of underground structures, foundations and utilities within the planned new building footprint.

We recommend **prior to excavation for any footings** that the entire building footprint (including 10 feet beyond the proposed building lines) be proof-rolled/compacted with a heavy vibratory drum roller as described in Section 6.1. In addition to improvement of general subgrade support for floor slabs, this general site compaction may help reduce or alleviate the amount of localized in-place densification of loose sands upon reaching bearing elevation in the footing excavations. If the excavated subgrade reveals loose soils at footing bearing elevation, additional in-place modification must be performed using a backhoe-mounted vibratory compactor (hoe-pac) or similar equipment to achieve a consistent bearing stratum. However, if seasonally high groundwater levels are present during excavation, excessive vibratory compaction may be detrimental to the footing subgrade, and compaction by “static” methods or removal and replacement with new engineered fill would be required.

Due to the encountered loose granular soils and soft cohesive soils, an inspection of the footing excavations should be completed to verify suitable bearing. Suitable compaction/bearing of granular foundation subgrade soils should be verified as:

- Exhibiting a compacted (in-situ) dry density of at least 100 percent of the maximum dry density determined by Standard Proctor (ASTM D 698) laboratory compaction,
- A dynamic cone penetrometer (DCP) reading of at least 8 blows per increment (average over three increments), or
- Other methods to demonstrate an equivalent SPT N-value of 10 bpf or greater.

Following the satisfactory completion of the site preparation and footing excavation inspections outlined in Section 6.0 of this report, the proposed structure may be supported on a conventional shallow spread foundation system consisting of wall (strip) and/or column (square) footings. Shallow foundations may be designed utilizing net allowable bearing pressures of 1,500 pounds per square foot (psf) for strip footings and 2,000 psf for square footings. In using net allowable soil pressures, the weight of the footings, backfill over the footings or floor slabs need not be included in the structural loads for dimensioning footings. The bearing materials should be field-verified as being:

- Native lean clays (CL) with a minimum unconfined compressive strength of 1,500 psf,
- Native silty sand (SM), poorly graded sand with silt (SP/SM), or clayey sand (SC) that exhibit suitable compactness/density as described above, or
- Properly placed and compacted new engineered fill.

Where soft cohesive soils, granular soils that cannot be suitably re-compacted in-place, or other unsuitable foundation soils are encountered, over-excavation should extend through these materials to suitable bearing soils. Additionally, the base of the over-excavation should be widened one foot for every foot of depth below the planned bearing depth, with the excavation centered along the footing. The over-excavated areas should be backfilled with dense-graded aggregate, placed in controlled lifts, and compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor). Alternatively, the over-excavated areas could be backfilled with lean concrete or other flowable controlled-density fill having a minimum compressive strength of 300 pounds per square inch (psi).

Due to the encountered loose granular soils, soft cohesive soils, and existing site development, we strongly recommend that the bearing surface at the bottom of all footing excavations be inspected during construction by a TTL geotechnical engineer or qualified representative. Inspection should be performed to verify that the exposed soil conditions at the bearing elevations are consistent with the subsurface conditions encountered in the test borings, and that new engineered fill is properly placed and compacted for suitable foundation bearing. Additionally, the presence of our engineer will help facilitate the timely remediation of unsuitable soil conditions. If the results of hand penetrometer, DCP, or other strength tests indicate the exposed soil conditions are not suitable for the design bearing pressure, it may be necessary to increase the footing size to accommodate the lower bearing strengths or to over-excavate and backfill with engineered fill or flowable fill.

All exterior footings and footings in unheated areas should be constructed at a minimum frost penetration depth of 3½ feet below finished exterior grades. Interior footings may bear at a convenient depth below the floor slab, provided they are supported on native soils as described above, or properly placed and compacted new engineered fill. Wall (strip) footings should be at least 18 inches wide and column (square) footings should be at least 30 inches square, regardless of sizing based on design loads and allowable bearing pressures.

Based on the above bearing pressures, a maximum column load assumed to be 100 kips, and maximum wall loads assumed to be 2,000 pounds per lineal foot, total settlement is not expected to exceed 1 inch, and differential settlement should not exceed ¾ inch.

5.2 Subgrades

It is assumed final site grades will approximate existing site grades at the time of our investigation. Therefore, subgrade soils are not anticipated to include cohesive soils, which were encountered in the borings at depths of 3 feet or greater below existing grades. If grades will be lowered such that cohesive soils are anticipated at subgrade elevations, a lower design subgrade support value (k-value) would be required for design of floor slabs supported by cohesive subgrade soils. Otherwise, the subgrade support values in this report for granular subgrade soils may be utilized, provided cohesive soils are over-excavated to a depth of at least 12 inches below subgrade elevation and replaced with new granular engineered fill.

5.2.1 Existing Subgrade

The subgrades that would result upon the satisfactory completion of the site preparation as described in Section 6.0 of this report are considered moderately acceptable for support of the proposed floor slabs. Based on field and laboratory data developed during this investigation, the soils anticipated to be exposed at subgrade elevations consist of granular fill materials, as well as native granular soils.

Based on visual descriptions of the granular subgrade soils encountered in the borings, these soils may be generally classified as Group A-3 or A-4 in accordance with the American Association of State Highway Transportation Officials (AASHTO) system of soil classification. These soils are considered good to fair as subgrade materials.

At the time of this investigation, the moisture contents in the upper 2½ feet of the granular subgrade soils varied from approximately 8 to 20 percent. These moisture contents are estimated to vary from near to significantly above the expected optimum moisture content for these soils. Therefore, remedial action should be anticipated to be required to adjust the moisture contents of the existing materials and achieve proper compaction of the subgrade. Remedial action should also be anticipated due to the **very loose to loose** compactness of the granular soils.

5.2.2 Modified Subgrade

Although not anticipated to be prevalent, if soils are dry of optimum, water should be uniformly mixed into the subgrade. More likely to be encountered are soils that are wet of optimum. Where soils wet of optimum are encountered, lowering the moisture content by scarification and aeration (discing and exposure to sun and wind) may be required. Very moist to wet soils will “pump” under the operation of heavy equipment, resulting in deep rutting and perhaps rendering the operation of grading and paving equipment difficult or impossible. The granular subgrade soils should be generally conducive for drying using scarification and aeration.

Other methods of subgrade modification may be required in areas of high moisture content. Modification may be achieved by undercutting and replacement with granular subbase (possibly in combination with a geotextile separation layer or geogrid reinforcement), mixing stone into the subgrade, or treating the subgrade with cement. The method of subgrade modification should be determined at the time of construction (See Section 6.1, “Construction Recommendations - Site and Subgrade Preparation”).

5.3 Floor Slabs

It is recommended that all floor slabs be “floating”, that is, fully ground supported and not structurally connected to walls or foundations. This is to reduce the possibility of cracking and displacement of the floor slabs because of differential movements between the slab and the foundation. Such movements could be detrimental to slabs that are rigidly connected to the foundations. There may be certain areas where it will be difficult or impractical to make the slab floating. In such areas, it may be necessary to increase the slab thickness and reinforcement to prevent the foundation from cracking the slab and settling independently.

For properly prepared **granular** subgrade soils, a modulus of subgrade reaction (k) of 150 pounds per cubic inch (pci) may be used for floor slab design. Although not anticipated, if grades will be lowered such that cohesive subgrade soils are anticipated or zones of cohesive subgrade soils are encountered shallower than in the borings, the cohesive soils should be over-excavated to a depth of at least 12 inches below subgrade elevation and replaced with new engineered fill. Otherwise, a design k-value of 135 pci would be appropriate for floor slabs supported by cohesive subgrade soils.

It is recommended that the floor slab be supported on a minimum 6-inch layer of relatively clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and provide more uniform subgrade support beneath the slab.

The existing fill materials encountered in the borings are generally suitable for slab support, provided they pass a proof roll as described in Section 6.1 of this report. However, as is the case with any existing fills, there is an increased risk that less favorable conditions are present between boring locations that increase the risk for settlement. If this risk is unacceptable, partial or full depth removal will be required.

5.4 Groundwater Control

As previously discussed, groundwater was initially encountered during drilling in each of the borings at depths ranging from 6 to 11 feet below existing grades, and was observed upon completion of drilling operations in two borings at depths of 17 feet and 18 feet. Groundwater was not observed upon completion of drilling in Boring B-3. Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that long-term “normal” groundwater level at the site will generally be encountered at depths of approximately 6 feet or greater below existing grades. However “perched” water may be encountered within the fill

materials or Stratum I granular soils that are underlain by relatively impermeable native cohesive soils.

It is our experience that adequate control of groundwater seepage, perched water, or surface water run-off into shallow excavations in predominantly cohesive profiles should be achievable by minor dewatering systems, such as pumping from prepared sumps. Installation of site utilities early in the site grading activities will also help to alleviate the “perched” water conditions. Excavations below the groundwater level in Stratum I granular soils may require installation of well points in addition to pumping from prepared sumps. In the event excessive seepage is encountered during construction, TTL may be notified to evaluate whether other dewatering methods are required.

5.5 Excavations and Slopes

The sides of temporary excavations for building foundations, utility installations, and other construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) safety standards must be followed.

Based on the test borings, it is likely that excavations will encounter a range of soil conditions that include the following OSHA designations:

- Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and
- Type C soils (existing fill materials, granular soils, and cohesive soils with unconfined compressive strength of 1,000 psf or less).

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than $\frac{3}{4}$ horizontal to 1 vertical ($\frac{3}{4}$ H:1V), 1H:1V, and $1\frac{1}{2}$ H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil, the slope of the entire excavation is governed by that required for the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

For permanent excavation slopes, we recommend that grades be no steeper than 3H:1V without a more extensive geotechnical evaluation of the proposed construction plans and site conditions.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Site and Subgrade Preparation

Prior to proceeding with construction operations, all structures, pavements, topsoil, root mat, vegetation, and other deleterious non-soil materials should be removed from the proposed construction areas. With regard to removal of existing floor slabs and foundations, we recommend the following:

- For existing structures which do not contain a basement, the floor slabs constructed as slabs-on-grade must be removed completely.
- Foundations for the existing structures which were constructed with slabs-on-grade must be removed completely in the proposed building area and should be removed down to the horizontal portion of the footing in proposed non-structural pavement areas, provided they will not interfere with installation of proposed underground utilities.

Suitable topsoil may be stockpiled for later use in landscape areas. **It should be noted that the topsoil thicknesses at the site may vary from that referenced in Boring B-1, and the actual amount of required stripping should be determined in the field by a geotechnical engineer or qualified representative.** Topsoil quantities may be limited due to the existing site development.

Due to the existing development at the site, the proof rolling and preparation of this site will require careful inspection. Voids remaining after footing removal and utility trench abandonment, and other exposed excavations should be backfilled with engineered fill, placed in controlled lifts and tested for suitable compaction in accordance with the criteria in Section 6.2 of this report. If such excavations are randomly filled or graded without compaction control, excessive differential settlement could occur.

Upon completion of the stripping and clearing, the areas intended to support floor slabs and/or new fill should be carefully inspected by a geotechnical engineer. At that time, the engineer should observe proof rolling/compaction of the granular subgrades using a vibratory, smooth-drum roller. Although not anticipated, if grades are lowered such that cohesive soils are present at subgrade elevations, they should be proof rolled utilizing a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight. The roller or truck should make a minimum of two passes covering the proposed development area, with additional passes as necessary to achieve required compaction and/or subgrade stabilization.

The purpose of proof rolling the cohesive subgrades is to locate any weak, soft, or excessively wet soils that may be present at the time of construction. The purpose of vibratory compaction for the granular soils is to densify zones of loose materials that are encountered in the upper portion of the soil profile, thereby providing more uniform subgrade support. We recommend a roller with a minimum dead weight on the drums of 8 tons, vibrating at 30 Hz or greater, and traveling at speeds not exceeding approximately 4 feet per second (about 3 miles per hour). These operational criteria should provide sufficient dynamic compaction energy to alleviate loose soil conditions within the zone of influence for subgrade support. If “perched” or seasonal high groundwater conditions are present during construction, proof rolling/compaction with the roller under “static” operations should be performed.

Any unsuitable materials observed during the inspection and proof-rolling operations should be undercut and replaced with compacted fill or stabilized in place utilizing conventional remedial measures such as discing, aeration, and recompaction. Once the site has been proof rolled, inspected, and stabilized, the proof-rolled or inspected subgrades should not be exposed to wet conditions. It should be recognized that during periods of wet weather, the silty/clayey soils that will be exposed at design subgrades will tend to pond water for short periods of time, with the potential to deteriorate the prepared subgrade.

The results of the inspection and proof-rolling operations will be partially dependent on construction operations, the moisture content of the soil, and the weather conditions prevalent at the time. If pumping or rutting is encountered and difficulty is experienced in the operation of construction equipment, TTL should be notified in order to determine which method of subgrade modification may be best suited for the conditions encountered. Should such conditions be experienced, we may recommend that a small test area be used to determine the necessary depth of undercutting and stone replacement or other remedial action necessary to achieve a stable subgrade condition.

6.2 Fill

Material for engineered fill or backfill required to achieve design grades may consist of any non-organic and non-expansive soils having a maximum dry density as determined by the Standard Proctor (ASTM D 698) greater than 90 pounds per cubic foot (pcf). On-site soils may be used as engineered fill materials provided that they are free of organic matter, debris, excessive moisture, and rock or stone fragments larger than 3 inches in diameter. Depending on seasonal conditions, the on-site soils may be wet of optimum and could require scarification and aeration to achieve satisfactory compaction.

Fill should be placed in uniform layers no more than 8 inches thick (loose measure) and adequately keyed into stripped and scarified soils. All fill within the building areas and pavement subgrades should be compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor).

The upper soil profile at the site consists of predominantly granular fill materials and native granular soils. The contractor should be prepared to use a vibratory, smooth-drum roller to provide effective compaction of these materials. If grades are lowered such that cohesive subgrade soils are exposed, the contractor should be prepared to use a sheepsfoot roller to provide effective compaction of the cohesive subgrade soils. In narrow utility or footing excavations, the on-site cohesive soils may be difficult to compact; therefore, a clean granular material may be required in these areas.

Scarified subgrade soils and all fill material should be within 3 percent of the optimum moisture content to facilitate compaction. Furthermore, fill material should not be frozen or placed on a frozen base. It is recommended that all earthwork and site preparation activities be conducted under adequate specifications and properly monitored in the field by a qualified geotechnical testing firm.

6.3 Foundation Excavations

As mentioned in Section 5.1, foundations used to support the structure should have a detailed footing inspection performed for each foundation. A geotechnical engineer or qualified representative should perform these inspections to verify that the exposed materials are similar to those encountered in the borings, loose granular soils have been suitably modified in-place, and that engineered fill has been properly placed and compacted such that it is capable of supporting the design bearing pressure.

We recommend that the foundation excavations be concreted as soon as practical after they are excavated and that water not be allowed to pond in any excavation. If it is necessary to leave the bearing surface open for any extended period of time, we recommend that a thin mat of lean concrete be placed over the bottom of the excavation to reduce damage to the surface from weather or construction. Foundation concrete should not be placed on frozen or saturated subgrade.

Additional shallow foundation footing preparation recommendations are provided in Section 5.1.

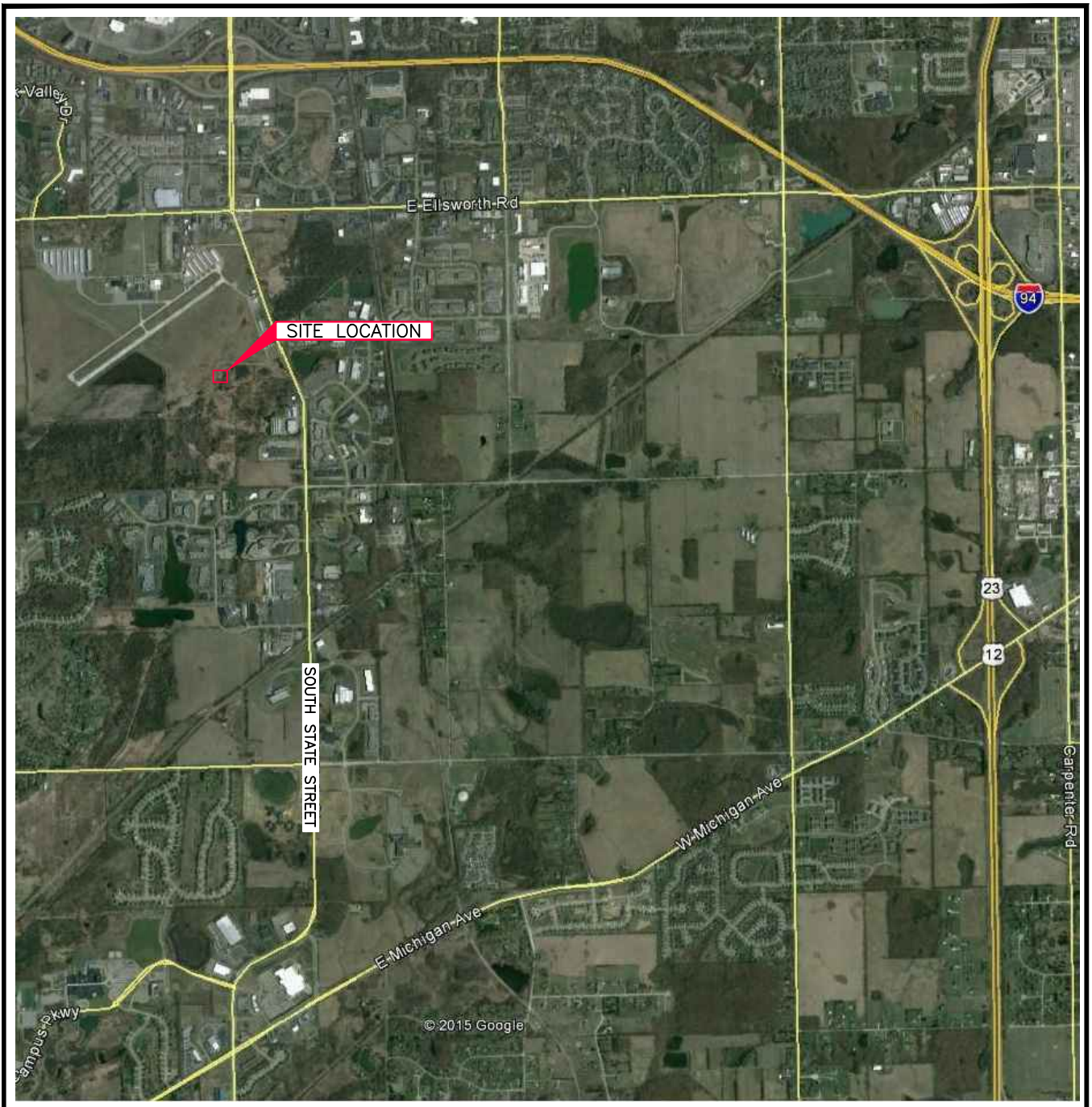
7.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluations of foundation and floor slab design and construction conditions have been based on the data obtained during our field investigation and our understanding of the furnished site and project information. The general subsurface conditions were based on interpretation of the data obtained at specific boring locations. Regardless of the thoroughness of a subsurface investigation, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. This is especially true of previously developed sites. Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, TTL assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, TTL should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

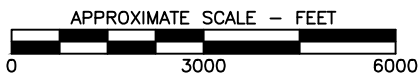
The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. TTL is not responsible for the conclusions, opinions, or recommendations of others based on this data.



LEGEND

— APPROXIMATE SITE LOCATION



**PLATE 1.0
SITE LOCATION MAP**

PROPOSED PRE-ENGINEERED METAL BUILDING
STEERE FARM AT THE ANN ARBOR MUNICIPAL AIRPORT
ANN ARBOR, MICHIGAN

PREPARED FOR
TETRA TECH
ANN ARBOR, MICHIGAN

DRAWN	TRR/10-20-15	CHECKED	KDC/10-21-15
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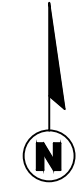
REVISED	APPROVED
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JOB NO. 13295.01

DRAWING NUMBER

1329501-01G





A-201
3

A-201
4

A-201
2

EXISTING
66" x 114"
VALVE
VAULT

EXISTING BUILDING SLAB ~20' x 28' FOR REFERENCE
LOUVER REMOVABLE FOR GENERATOR INSTALLATION

PUMP BASE
42" x 42" x 9" TALL

VFD

MCC-G

ATS

MCC-A

B-1

FUTURE GENERATOR

25' - 8"

11' - 0"

8' - 0"

16' - 4"

10' - 0"

28' - 0"

B-3

4' - 0"

14' - 0"

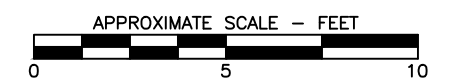
3' - 4"

56' - 4"

35' - 0"

LEGEND

B-1 APPROXIMATE TEST BORING LOCATION



PROPOSED FLOOR PLAN

PLATE 2.0	
TEST BORING LOCATION PLAN	
PROPOSED PRE-ENGINEERED METAL BUILDING STEERE FARM AT THE ANN ARBOR MUNICIPAL AIRPORT ANN ARBOR, MICHIGAN	
PREPARED FOR TETRA TECH ANN ARBOR, MICHIGAN	
DRAWN TRR/10-20-15	CHECKED KDC/10-21-15
REVISED	APPROVED
JOB NO. 13295.01	
DRAWING NUMBER 1329501-02G	



TTL Associates, Inc.
 1915 N 12th Street
 Toledo, Ohio 43624
 Telephone: 419-324-2222
 Fax: 419-241-1808

BORING NUMBER B-1

PAGE 1 OF 1

CLIENT Tetra Tech **PROJECT NAME** Proposed Pre-Engineered Metal Building
PROJECT NUMBER 13295.01 **PROJECT LOCATION** Ann Arbor, MI
DRILLING CONTRACTOR TTL Associates CM MM **RIG NO.** 45 **GROUND ELEVATION** _____
DRILLING METHOD 2-3/4 in. HSA **GROUND WATER LEVELS:**
DATE STARTED 10/16/15 **COMPLETED** 10/16/15 **▽ AT TIME OF DRILLING** 6.0 ft
LOGGED BY KKC **CHECKED BY** KDC **▼ AT END OF DRILLING** 18.0 ft
NOTES _____ **0hrs AFTER DRILLING** Backfilled w/Cuttings and Bentonite Chips

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL			
									20	40	60	80
	0		TOPSOIL - 8 Inches									
	0.7'		Moist Loose Black/Brown SILTY SAND w/Trace Organics (SM)	SS 1	100	3-3-4 (7)	NP					▲ 14
	3.0'		Moist Medium Dense Brown POORLY GRADED SAND w/Silt and Trace Gravel (SP/SM)	SS 2	100	6-7-8 (15)	NP					● 15
	6.0'	▽	Wet Loose Brown POORLY GRADED SAND w/Silt and Trace Gravel (SP/SM)	SS 3a	100	6-4	NP					● 14
	7.0'		Moist Medium Stiff Gray SANDY LEAN CLAY (CL)	SS 3a	100	3	0.75					● 23
	8.5'		Moist Stiff Gray SANDY LEAN CLAY (CL)	SS 4	100	6-7-6 (13)	NI	108				● 16
	13.0'		Moist Very Stiff Gray LEAN CLAY w/Sand (CL)	SS 5	100	4-9-11 (20)	3.25					● 19
	20.0'	▼	Bottom of hole at 20.0 feet.	SS 6	100	6-7-9 (16)	2.50					▲ 23

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TTL Associates, Inc.
 1915 N 12th Street
 Toledo, Ohio 43624
 Telephone: 419-324-2222
 Fax: 419-241-1808

BORING NUMBER B-2

PAGE 1 OF 1

CLIENT Tetra Tech **PROJECT NAME** Proposed Pre-Engineered Metal Building

PROJECT NUMBER 13295.01 **PROJECT LOCATION** Ann Arbor, MI

DRILLING CONTRACTOR TTL Associates CM MM **RIG NO.** 45 **GROUND ELEVATION** _____

DRILLING METHOD 2-3/4 in. HSA **GROUND WATER LEVELS:**

DATE STARTED 10/16/15 **COMPLETED** 10/16/15 **▽ AT TIME OF DRILLING** 6.0 ft

LOGGED BY KKC **CHECKED BY** KDC **▼ AT END OF DRILLING** 17.0 ft

NOTES _____ **0hrs AFTER DRILLING** Backfilled w/Cuttings and Bentonite Chips

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL MC LL					
									20	40	60	80		
0	0		CRUSHED STONE - 8 Inches											
	0.7'		FILL - Moist Loose Black/Brown CLAYEY SAND w/Trace Crushed Stone	SS 1	100	2-4-4 (8)	NP							
	3.0'		Moist Soft to Medium Stiff Gray LEAN CLAY w/Trace Sand (CL)	SS 2	100	2-2-2 (4)	0.97	99						
5	6.0'		Wet Loose Gray CLAYEY SAND (SC) (Free Water Noted in Jar)	SS 3	100	4-4-4 (8)	NP							
	9.0'		Moist Medium Stiff Gray LEAN CLAY w/Sand (CL)	SS 4	100	4-3-5 (8)	0.57	109						
10	13.5'		Moist Very Stiff Gray LEAN CLAY w/Sand (CL)	SS 5	100	10-9-10 (19)	4.00							
15	18.5'		@18.5': Stiff	SS 6	100	7-7-7 (14)	3.50							
20	20.0'		Bottom of hole at 20.0 feet.											

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BORING NUMBER B-3

PAGE 1 OF 1

CLIENT Tetra Tech **PROJECT NAME** Proposed Pre-Engineered Metal Building

PROJECT NUMBER 13295.01 **PROJECT LOCATION** Ann Arbor, MI

DRILLING CONTRACTOR TTL Associates CM MM **RIG NO.** 45 **GROUND ELEVATION** _____

DRILLING METHOD 2-3/4 in. HSA **GROUND WATER LEVELS:**

DATE STARTED 10/16/15 **COMPLETED** 10/16/15 **▽ AT TIME OF DRILLING** 11.0 ft

LOGGED BY KKC **CHECKED BY** KDC **AT END OF DRILLING** None





















NOTES _____ **0hrs AFTER DRILLING** Backfilled w/Cuttings and Bentonite Chips

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	SPT N VALUE ▲			
									PL	MC	LL	
0	0		CRUSHED STONE - 6 Inches									
	0.5'		FILL - Moist Very Loose Black/Brown CLAYEY SAND w/Trace Crushed Stone	SS 1	56	2-2-2 (4)	NP		8			
	3.0'		Moist Brown/Gray CLAYEY SAND (SC)				NP					
	4.5'		Moist Medium Stiff Brown/Gray SANDY LEAN CLAY (CL)	ST 1	100		0.75					
5	5.5'		Moist Medium Stiff Brown/Gray LEAN CLAY w/Sand (CL)				1.00	96		26		
	6.0'		Moist Soft Gray SANDY LEAN CLAY (CL)	SS 2	100	0-0-4 (4)	0.25		17			
	8.5'		Moist Stiff Brown/Gray SANDY LEAN CLAY w/Trace Gravel (CL)	SS 3	100	4-5-5 (10)	3.75		12			
10		▽										
	13.0'		Moist Very Stiff Gray LEAN CLAY w/Sand (CL)	SS 4	100	5-7-11 (18)	>4.5		19			
15												
	20.0'		Bottom of hole at 20.0 feet.	SS 5	100	6-8-8 (16)	2.75		24			







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LEGEND KEY

Unified Soil Classification System Soil Symbols

 GW - WELL GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.	 GP - POORLY GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.	 GM - SILTY GRAVEL Includes Gravel-Sand-Silt mixtures.	 GC - CLAYEY GRAVEL Includes Gravel-Sand-Clay mixtures.
 SW - WELL GRADED SAND Includes Gravelly Sands, little or no fines.	 SP - POORLY GRADED SAND Includes Gravelly Sands, little or no fines.	 SM - SILTY SAND Includes Sand-Silt mixtures.	 SC - CLAYEY SAND Includes Sand-Clay mixtures.
 ML - SILT Includes Silt with Sand and Sandy Silt.	 CL - LEAN CLAY Includes Sandy Lean Clay and Lean Clay with Sand and Gravel.	 MH - ELASTIC SILT Includes Sandy Elastic Silt and Elastic Silt with Sand.	 CH - FAT CLAY Includes Sandy Fat Clay and Fat Clay with Sand.
 CL-ML - SILTY CLAY Includes Clayey Silt of low plasticity.	 OL - ORGANIC SILT and ORGANIC CLAY of low plasticity.	 OH - ORGANIC SILT and ORGANIC CLAY of medium to high plasticity.	 Pt - PEAT Includes humus, swamp and other soils with high organic content.
 FILL MATERIAL - Includes controlled and non-controlled soil and non-soil materials.	 TOPSOIL	 ASPHALT - Bituminous Asphalt	 CONCRETE - Includes broken concrete rubble.

Sample Symbols

 SS - Split Spoon	 ST - Shelby Tube	 RC - Rock Core	 GS - Geoprobe Sleeve
	 AU - Auger Cuttings	 GB - Grab	

Notes:

1. Exploratory borings were drilled on October 16, 2015, using 2³/₄-inch inside diameter hollow-stem augers.
2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.
3. Boring locations were established in the field by TTL Associates, Inc in general accordance with the site plan provided by Tetra Tech.
4. Unconfined Compressive Strength (tsf):
NP = Non-Plastic
NI = Not Intact

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)	Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification		
							Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index			
B-1	SS-1	1.0-2.5	7	14.0														
	SS-2	3.5-5.0	15	15.0														
	SS-3a	6.0-7.0	7	13.5														
	SS-3b	7.0-7.5		23.2	*1,500													
	SS-4	8.5-10.0	13	16.3	107.5													
	SS-5	13.5-15.0	20	19.5		*6,500												
	SS-6	18.5-20.0	16	23.4		*5,000												
B-2	SS-1	1.0-2.5	8	20.2														
	SS-2	3.5-5.0	4	24.6	99.4	1,945	0	1	1	2	20	76	33	21	12	CL		
	SS-3	6.0-7.5	8	18.0														
	SS-4	8.5-10.0	8	14.3	109.2	1,145												
	SS-5	13.5-15.0	19	19.7		*8,000												
	SS-6	18.5-20.0	14	24.1		*7,000												

*Unconfined compressive strength derived from a calibrated hand penetrometer

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)	Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification		
							Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index			
B-3	SS-1	1.0-2.5	4	7.6														
	ST-1	4.0-6.0																
		5.0				*1,500												
		5.5			26.2	96.3	1,995											
	SS-2	6.0-7.5	4	17.1		*500												
	SS-3	8.5-10.0	10	11.6		*7,500												
	SS-4	13.5-15.0	18	19.5		*9,000+												
	SS-5	18.5-20.0	16	23.6		*5,500												

*Unconfined compressive strength derived from a calibrated hand penetrometer



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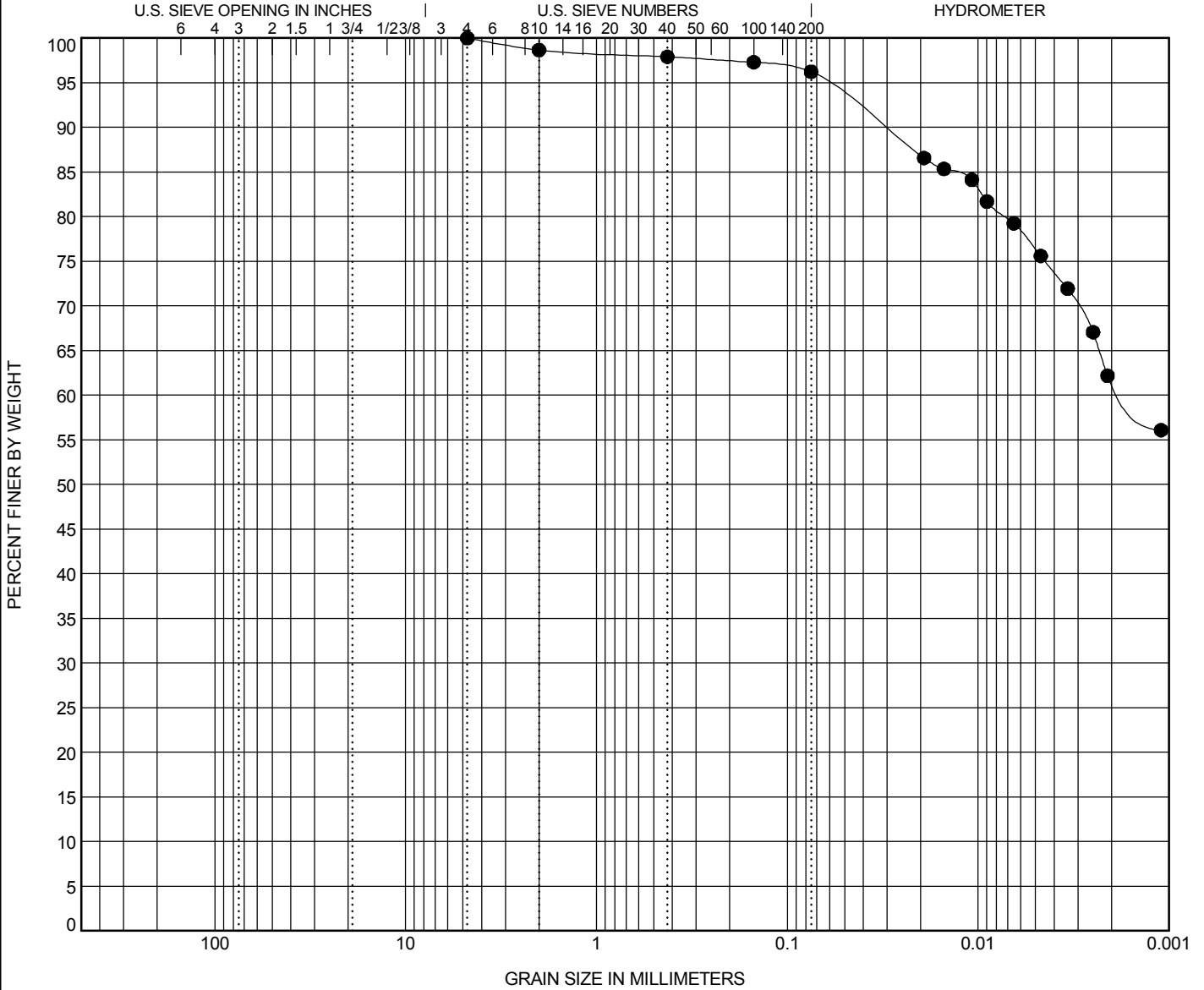
GRAIN SIZE DISTRIBUTION

CLIENT Tetra Tech

PROJECT NAME Proposed Pre-Engineered Metal Building

PROJECT NUMBER 13295.01

PROJECT LOCATION Ann Arbor, MI



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	USCS Classification	LL	PL	PI	Cc	Cu
● B-2 3.5	LEAN CLAY (CL)	33	21	12		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-2 3.5	4.75	0.002			0.0	3.8	19.9	76.3

GRAIN SIZE 13295.01.GPJ GINT US LAB.GDT 10/22/15

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APPENDIX E

INSURANCE AND ENDORSEMENT TEMPLATE

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CERTIFICATE OF LIABILITY INSURANCE

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement.

PRODUCER, CONTACT, INSURED, INSURER A-E, NAIC #

COVERAGES CERTIFICATE NUMBER: REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED.

Table with columns: INSR LTR, TYPE OF INSURANCE, ADDL SUBR INSR WVD, POLICY NUMBER, POLICY EFF (MM/DD/YYYY), POLICY EXP (MM/DD/YYYY), LIMITS. Rows include General Liability, Automobile Liability, Umbrella Liab, Workers Compensation, and Lease/Rented Eqpt.

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101. Additional Remarks Schedule, if more space is required) RE: Job Description: Water Treatment Plant, ITB#4, City of Ann Arbor is included as additional insured in accordance with the (See Attached Descriptions)

CERTIFICATE HOLDER: City of Ann Arbor Michigan, Attn: Water Treatment Plant, 301 East Huron St, Ann Arbor, MI 48104. CANCELLATION: SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS. AUTHORIZED REPRESENTATIVE

DESCRIPTIONS (Continued from Page 1)

policy provisions of the general liability and automobile liability policies as required by written contract. General Liability policy evidenced herein is primary to other insurance available to an additional insured but only in accordance with the policy's provisions as required by written contract. A waiver of subrogation is granted in favor of City of Ann Arbor, Michigan in accordance with the policy provisions of the General Liability, Auto Liability and Workers Compensation policies as required by written contract. 30 Day Notice of Cancellation applies. (11/15)

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

CONTRACTOR'S BLANKET ADDITIONAL INSURED ENDORSEMENT

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE FORM

Policy Number	Agency Number	Policy Effective Date
Policy Expiration Date	Date	Account Number
Named Insured	Agency	Issuing Company

1. a. **SECTION II - WHO IS AN INSURED** is amended to add as an insured any person or organization:
 - (1) Whom you are required to add as an additional insured on this policy under a written contract or written agreement relating to your business; or
 - (2) Who is named as an additional insured under this policy on a certificate of insurance.
- b. The written contract, written agreement, or certificate of insurance must:
 - (1) Require additional insured status for a time period during the term of this policy; and
 - (2) Be executed prior to the "bodily injury", "property damage", or "personal and advertising injury" leading to a claim under this policy.
- c. If, however:
 - (1) "Your work" began under a letter of intent or work order; and
 - (2) The letter of intent or work order led to a written contract or written agreement within 30 days of beginning such work; and
 - (3) Your customer's customary contracts require persons or organizations to be named as additional insureds;

we will provide additional insured status as specified in this endorsement.
2. **SECTION II - WHO IS AN INSURED** is amended to add the following:

If the additional insured is:

 - a. An individual, their spouse is also an additional insured.
 - b. A partnership or joint venture, members, partners, and their spouses are also additional insureds.
 - c. A limited liability company, members and managers are also additional insureds.
 - d. An organization other than a:
 - (1) Partnership;
 - (2) Joint venture; or
 - (3) Limited liability company;

executive officers and directors of the organization are also additional insureds. Stockholders are also additional insureds, but only with respect to their liability as stockholders.
 - e. A trust, trustees are also insureds, but only with respect to their duties as trustees.

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3. The insurance provided under this endorsement is limited as follows:

- a. That person or organization is an additional insured only with respect to liability arising out of:
 - (1) Premises you:
 - (a) Own;
 - (b) Rent;
 - (c) Lease; or
 - (d) Occupy; or
 - (2) Ongoing operations performed by you or on your behalf. If, however, the written contract, written agreement, or certificate of insurance also requires completed operations coverage, we will also provide completed operations coverage for that additional insured.
- b. Premises, as respects paragraph **3.a.(1)** above, include common or public areas about such premises if so required in the written contract or written agreement.
- c. Additional insured status provided under paragraphs **3.a.(1)(b)** or **3.a.(1)(c)** above does not extend beyond the end of a premises lease or rental agreement.
- d. Ongoing operations, as respects paragraph **3.a.(2)** above, does not apply to "bodily injury" or "property damage" occurring after:
 - (1) All work to be performed by you or on your behalf for the additional insured(s) at the site of the covered operations is complete, including related materials, parts or equipment (other than service, maintenance or repairs); or
 - (2) That portion of "your work" out of which the injury or damage arises is put to its intended use by any person or organization other than another contractor working for a principal as a part of the same project.
- e. The limits of insurance that apply to the additional insured are the least of those specified in the:
 - (1) Written contract;
 - (2) Written agreement;
 - (3) Certificate of insurance; or
 - (4) Declarations of this policy.

The limits of insurance are inclusive of and not in addition to the limits of insurance shown in the Declarations.
- f. The insurance provided to the additional insured does not apply to "bodily injury", "property damage", or "personal and advertising injury" arising out of an architect's, engineer's, or surveyor's rendering of, or failure to render, any professional services, including but not limited to:
 - (1) The preparing, approving, or failing to prepare or approve:
 - (a) Maps;
 - (b) Drawings;
 - (c) Opinions;
 - (d) Reports;
 - (e) Surveys;
 - (f) Change orders;
 - (g) Design specifications; and
 - (2) Supervisory, inspection, or engineering services.

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- g. **SECTION IV – COMMERCIAL GENERAL LIABILITY CONDITIONS**, paragraph 4. **Other Insurance** is deleted and replaced with the following:

4. Other Insurance.

Coverage provided by this endorsement is excess over any other valid and collectible insurance available to the additional insured whether:

- a. Primary;
- b. Excess;
- c. Contingent; or
- d. On any other basis;

unless the written contract, written agreement, or certificate of insurance requires this insurance be primary. In that case, this insurance will be primary without contribution from such other insurance available to the additional insured.

- h. If the written contract, written agreement, or certificate of insurance as outlined above requires additional insured status by use of CG 20 10 11 85, then the terms of that endorsement, shown below, are incorporated into this endorsement to the extent such terms do not restrict coverage otherwise provided by this endorsement:

<p style="text-align: center;">ADDITIONAL INSURED - OWNERS, LESSEES OR CONTRACTORS (FORM B)</p> <p>This endorsement modifies insurance provided under the following:</p> <p style="text-align: center;">COMMERCIAL GENERAL LIABILITY COVERAGE PART. SCHEDULE</p> <p>Name of Person or Organization: Blanket Where Required by Written Contract, Agreement, or Certificate of Insurance that the terms of CG 20 10 11 85 apply</p> <p>(If no entry appears above, information required to complete this endorsement will be shown in the Declarations as applicable to this endorsement.)</p> <p>WHO IS AN INSURED (Section II) is amended to include as an insured the person or organization shown in the Schedule, but only with respect to liability arising out of "your work" for that insured by or for you.</p> <p style="text-align: center;">Copyright, Insurance Services Office, Inc., 1984</p> <p>CG 20 10 11 85</p>

- i. If the written contract, written agreement, or certificate of insurance as outlined above requires additional insured status by use of an Insurance Services Office (ISO) endorsement, then the coverage provided under this CG 70 48 endorsement does not apply. Additional insured status is limited to that provided by the ISO endorsement.

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ADVANTAGE COMMERCIAL AUTOMOBILE BROAD FORM ENDORSEMENT

This endorsement modifies insurance provided under the

BUSINESS AUTO COVERAGE FORM

With respect to coverage provided by this endorsement, the provisions of the Coverage Form apply unless modified by the endorsement.

The premium for this endorsement is \$ INCLUDED

1. EXTENDED CANCELLATION CONDITION

COMMON POLICY CONDITIONS - CANCELLATION, Paragraph A.2. is replaced by the following:

2. We may cancel this policy by mailing or delivering to the first Named Insured written notice of cancellation at least:
 - a. 10 days before the effective date of cancellation if we cancel for nonpayment of premium; or
 - b. 60 days before the effective date of cancellation if we cancel for any other reason.

2. BROAD FORM INSURED

SECTION II - LIABILITY COVERAGE A.1. WHO IS AN INSURED is amended by the addition of the following:

- d. Any organization you newly acquire or form, other than a partnership, joint venture or limited liability company, and over which you maintain ownership or a majority interest, will qualify as a Named Insured. However,
 - (1) Coverage under this provision is afforded only until the end of the policy period;
 - (2) Coverage does not apply to "accidents" or "loss" that occurred before you acquired or formed the organization; and
 - (3) Coverage does not apply to an organization that is an "insured" under any other policy or would be an "insured" but for its termination or the exhausting of its limit of insurance.
- e. Any "employee" of yours using:
 - (1) A covered "auto" you do not own, hire or borrow, or a covered "auto" not owned by the "employee" or a member of his or her household, while performing duties related to the conduct of your business or your personal affairs; or
 - (2) An "auto" hired or rented under a contract or agreement in that "employee's" name, with your permission, while performing duties related to the conduct of your business. However, your "employee" does not qualify as an Insured under this paragraph (2) while using a covered "auto" rented from you or from any member of the "employee's" household.
- f. Your members, if you are a limited liability company, while using a covered "auto" you do not own, hire, or borrow, while performing duties related to the conduct of your business or your personal affairs.
- g. Any person or organization with whom you agree in a written contract, written agreement or permit, to provide insurance such as is afforded under this policy, but only with respect to your covered "autos".

This provision does not apply:

 - (1) Unless the written contract or agreement is executed or the permit is issued prior to the "bodily injury" or "property damage";

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- (2) To any person or organization included as an insured by an endorsement or in the Declarations; or
- (3) To any lessor of "autos" unless:
 - (a) The lease agreement requires you to provide direct primary insurance for the lessor;
 - (b) The "auto" is leased without a driver; and
 - (c) The lease had not expired.

Leased "autos" covered under this provision will be considered covered "autos" you own and not covered "autos" you hire.

- h. Any legally incorporated organization or subsidiary in which you own more than 50% of the voting stock on the effective date of this endorsement.

This provision does not apply to "bodily injury" or "property damage" for which an "insured" is also an insured under any other automobile policy or would be an insured under such a policy, but for its termination or the exhaustion of its limits of insurance, unless such policy was written to apply specifically in excess of this policy.

3. COVERAGE EXTENSIONS - SUPPLEMENTARY PAYMENTS

Under **SECTION II - LIABILITY COVERAGE, A.2.a. Supplementary Payments**, paragraphs (2) and (4) are deleted and replaced with the following:

- (2) Up to \$2500 for the cost of bail bonds (including bonds for related traffic law violations) required because of an "accident" we cover. We do not have to furnish these bonds.
- (4) All reasonable expenses incurred by the "insured" at our request, including actual loss of earnings up to \$500 a day because of time off from work.

4. AMENDED FELLOW EMPLOYEE EXCLUSION

SECTION II - LIABILITY COVERAGE, B. EXCLUSIONS, paragraph **5. Fellow Employee** is deleted and replaced by the following:

5. Fellow Employee

"Bodily injury" to:

- a. Any fellow "employee" of the "insured" arising out of and in the course of the fellow "employee's" employment or while performing duties related to the conduct of your business. However, this exclusion does not apply to your "employees" that are officers, managers, supervisors or above. Coverage is excess over any other collectible insurance.
- b. The spouse, child, parent, brother or sister of that fellow "employee" as a consequence of paragraph a. above.

5. HIRED AUTO PHYSICAL DAMAGE COVERAGE AND LOSS OF USE EXPENSE

A. Under SECTION III - PHYSICAL DAMAGE COVERAGE, A. COVERAGE, the following is added:

If any of your owned covered "autos" are covered for Physical Damage, we will provide Physical Damage coverage to "autos" that you or your "employees" hire or borrow, under your name or the "employee's" name, for the purpose of doing your work. We will provide coverage equal to the broadest physical damage coverage applicable to any covered "auto" shown in the Declarations, Item Three, Schedule of Covered Autos You Own, or on any endorsements amending this schedule.

B. Under SECTION III - PHYSICAL DAMAGE COVERAGE, A.4. COVERAGE EXTENSIONS, paragraph **b. Loss of Use Expenses** is deleted and replaced with the following:

b. Loss Of Use Expenses

For Hired Auto Physical Damage, we will pay expenses for which an "insured" becomes legally responsible to pay for loss of use of a vehicle rented or hired without a driver, under a written rental contract or agreement. We will pay for loss of use expenses if caused by:

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- (1) Other than collision, only if the Declarations indicate that Comprehensive Coverage is provided for any covered "auto";
- (2) Specified Causes of Loss, only if the Declarations indicate that Specified Causes Of Loss Coverage is provided for any covered "auto"; or
- (3) Collision, only if the Declarations indicate that Collision Coverage is provided for any covered "auto".

However, the most we will pay for any expenses for loss of use is \$30 per day, to a maximum of \$2,000.

C. Under **SECTION IV – BUSINESS AUTO CONDITIONS**, paragraph 5.b. **Other Insurance** is deleted and replaced by the following:

b. For Hired Auto Physical Damage Coverage, the following are deemed to be covered "autos" you own:

1. Any covered "auto" you lease, hire, rent or borrow; and
2. Any covered "auto" hired or rented by your "employee" under a contract in that individual "employee's" name, with your permission, while performing duties related to the conduct of your business.

However, any "auto" that is leased, hired, rented or borrowed with a driver is not a covered "auto", nor is any "auto" you hire from any of your "employees", partners (if you are a partnership), members (if you are a limited liability company), or members of their households.

6. LOAN OR LEASE GAP COVERAGE

Under **SECTION III - PHYSICAL DAMAGE COVERAGE, A. COVERAGE**, the following is added:

If a covered "auto" is owned or leased and if we provide Physical Damage Coverage on it, we will pay, in the event of a covered total "loss", any unpaid amount due on the lease or loan for a covered "auto", less:

- (a) The amount paid under the Physical Damage Coverage Section of the policy; and
- (b) Any:
 - (1) Overdue lease or loan payments including penalties, interest or other charges resulting from overdue payments at the time of the "loss";
 - (2) Financial penalties imposed under a lease for excessive use, abnormal wear and tear or high mileage;
 - (3) Costs for extended warranties, Credit Life Insurance, Health, Accident or Disability Insurance purchased with the loan or lease;
 - (4) Security deposits not refunded by a lessor; and
 - (5) Carry-over balances from previous loans or leases.

7. RENTAL REIMBURSEMENT

SECTION III - PHYSICAL DAMAGE COVERAGE, A. COVERAGE, paragraph 4. **Coverage Extensions** is deleted and replaced by the following:

4. Coverage Extensions

- (a) We will pay up to \$75 per day to a maximum of \$2000 for transportation expense incurred by you because of covered "loss". We will pay only for those covered "autos" for which you carry Collision Coverage or either Comprehensive Coverage or Specified Causes of Loss Coverage. We will pay for transportation expenses incurred during the period beginning 24 hours after the covered "loss" and ending, regardless of the policy's expiration, when the covered "auto" is returned to use or we pay for its "loss". This coverage is in addition to the otherwise applicable coverage you have on a covered "auto". No deductibles apply to this coverage.
- (b) This coverage does not apply while there is a spare or reserve "auto" available to you for your operation.

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8. AIRBAG COVERAGE

SECTION III - PHYSICAL DAMAGE, B. EXCLUSIONS, Paragraph 3. is deleted and replaced by the following:

We will not pay for "loss" caused by or resulting from any of the following unless caused by other "loss" that is covered by this insurance:

- a. Wear and tear, freezing, mechanical or electrical breakdown. However, this exclusion does not include the discharge of an airbag.
- b. Blowouts, punctures or other road damage to tires.

9. GLASS REPAIR - WAIVER OF DEDUCTIBLE

SECTION III - PHYSICAL DAMAGE COVERAGE, D. DEDUCTIBLE is amended to add the following:

No deductible applies to glass damage if the glass is repaired rather than replaced.

10. COLLISION COVERAGE – WAIVER OF DEDUCTIBLE

SECTION III - PHYSICAL DAMAGE COVERAGE, D. DEDUCTIBLE is amended to add the following:

When there is a "loss" to your covered "auto" insured for Collision Coverage, no deductible will apply if the "loss" was caused by a collision with another "auto" insured by us.

11. KNOWLEDGE OF ACCIDENT

SECTION IV - BUSINESS AUTO CONDITIONS, A. LOSS CONDITIONS, 2. DUTIES IN THE EVENT OF ACCIDENT, CLAIM, SUIT OR LOSS, paragraph a. is deleted and replaced by the following:

- a. You must see to it that we are notified as soon as practicable of an "accident", claim, "suit" or "loss". Knowledge of an "accident", claim, "suit" or "loss" by your "employees" shall not, in itself, constitute knowledge to you unless one of your partners, executive officers, directors, managers, or members (if you are a limited liability company) has knowledge of the "accident", claim, "suit" or "loss". Notice should include:
 - (1) How, when and where the "accident" or "loss" occurred;
 - (2) The "insured's" name and address; and
 - (3) To the extent possible, the names and addresses of any injured persons and witnesses.

12. TRANSFER OF RIGHTS (BLANKET WAIVER OF SUBROGATION)

SECTION IV - BUSINESS AUTO CONDITIONS A.5. TRANSFER OF RIGHTS OF RECOVERY AGAINST OTHERS TO US is deleted and replaced by the following:

If any person or organization to or for whom we make payment under this Coverage Form has rights to recover damages from another, those rights are transferred to us. That person or organization must do everything necessary to secure our rights and must do nothing after "accident" or "loss" to impair them. However, if the insured has waived rights to recover through a written contract, or if your work was commenced under a letter of intent or work order, subject to a subsequent reduction in writing with customers whose customary contracts require a waiver, we waive any right of recovery we may have under this Coverage Form.

13. UNINTENTIONAL FAILURE TO DISCLOSE HAZARDS

SECTION IV - BUSINESS AUTO CONDITIONS, B. GENERAL CONDITIONS, 2. CONCEALMENT, MISREPRESENTATION OR FRAUD is amended by the addition of the following:

We will not deny coverage under this Coverage Form if you unintentionally fail to disclose all hazards existing as of the inception date of this policy. You must report to us any knowledge of an error or omission in your representations as soon as practicable after its discovery. This provision does not affect our right to collect additional premium or exercise our right of cancellation or non-renewal.

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14. BLANKET COVERAGE FOR CERTAIN OPERATIONS IN CONNECTION WITH RAILROADS

When required by written contract or written agreement, the definition of "insured contract" is amended as follows:

— The exception contained in paragraph **H.3.** relating to construction or demolition operations on or within 50 feet of a railroad; and

— Paragraph **H.a.**

are deleted with respect to the use of a covered "auto" in operations for, or affecting, a railroad.

**THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.
POLICY CHANGES**

POLICY CHANGE NUMBER: 4

POLICY NUMBER	POLICY CHANGES EFFECTIVE	COMPANY
ACCOUNT NUMBER	POLICY PERIOD	GROUP NAME GROUP NUMBER
NAMED INSURED		AUTHORIZED REPRESENTATIVE
COVERAGE PARTS AFFECTED GL		
CHANGES		
<input type="checkbox"/> Insured's Name	<input type="checkbox"/> Insured's Mailing Address	
<input type="checkbox"/> Policy Number	<input type="checkbox"/> Company	
<input type="checkbox"/> Effective/Expiration Date	<input type="checkbox"/> Insured's Legal Status/Business of Insured	
<input type="checkbox"/> Payment Plan	<input type="checkbox"/> Premium Determination	
<input type="checkbox"/> Additional Interested Parties	<input type="checkbox"/> Coverage Forms and Endorsements	
<input type="checkbox"/> Limits/Exposures	<input type="checkbox"/> Deductibles	
<input type="checkbox"/> Covered Property/Location Description	<input type="checkbox"/> Classification/Class Codes	
<input type="checkbox"/> Rates	<input type="checkbox"/> Underlying Insurance	

DESCRIPTION OF CHANGE:

ADDING A 30 DAY NOTICE OF CANCELLATION IN FAVOR OF THE CITY OF ANN ARBOR MICHIGAN

THE ABOVE AMENDMENTS RESULT IN A CHANGE IN THE PREMIUM AS FOLLOWS:

<input checked="" type="checkbox"/> NO CHANGES	<input type="checkbox"/> TO BE ADJUSTED AT AUDIT	ADDITIONAL PREMIUM	RETURN PREMIUM
This endorsement reflects a net premium change Total Policy Premium: Taxes and Surcharges: Balance to Minimum:			

AUTHORIZED REPRESENTATIVE SIGNATURE

IL 70 44 07 08

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12/07/2015

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

NOTICE OF CANCELLATION, NONRENEWAL OR MATERIAL CHANGE - THIRD PARTY

This endorsement modifies insurance provided under the following:

AUTO DEALERS COVERAGE FORM
BUSINESS AUTO COVERAGE FORM
BUSINESS AUTO PHYSICAL DAMAGE COVERAGE FORM
COMMERCIAL GENERAL LIABILITY COVERAGE FORM
COMMERCIAL UMBRELLA LIABILITY COVERAGE FORM
GARAGE COVERAGE FORM
MOTOR CARRIER COVERAGE FORM
PRODUCTS/COMPLETED OPERATIONS LIABILITY COVERAGE FORM
TRUCKERS COVERAGE FORM

Subject to the cancellation provisions of the Coverage Form to which this endorsement is attached, we will not:

1. Cancel;
2. Nonrenew; or
3. Materially change (reduce or restrict)

this Coverage Form until we provide at least 30 days written notice of such cancellation, nonrenewal or material change. Written notice will be to the person or organization named in the Schedule. Such notice will be by certified mail with return receipt requested.

This notification of cancellation, nonrenewal or material change to the person or organization named in the Schedule is intended as a courtesy only. Our failure to provide such notification will not:

1. Extend any Coverage Form cancellation date;
2. Negate the cancellation as to any insured or any certificate holder;
3. Provide any additional insurance that would not have been provided in the absence of this endorsement;
or
4. Impose liability of any kind upon us.

This endorsement does not entitle the person or organization named in the Schedule to any benefits, rights or protection under this Coverage Form.

SCHEDULE

Name Of Person Or Organization

CITY OF ANN ARBOR MICHIGAN

Mailing Address

301 EAST HURON STREET
ANN ARBOR, MI 48104

Forms and Endorsements Schedule

Policy Number:

Effective Date:

Named Insured:

Form Number

Description

COMMON FORMS

IL 70 68 07 14

NOTICE OF CANCELLATION, NONRENEWAL OR MATERIAL CHANGE - THIRD PARTY

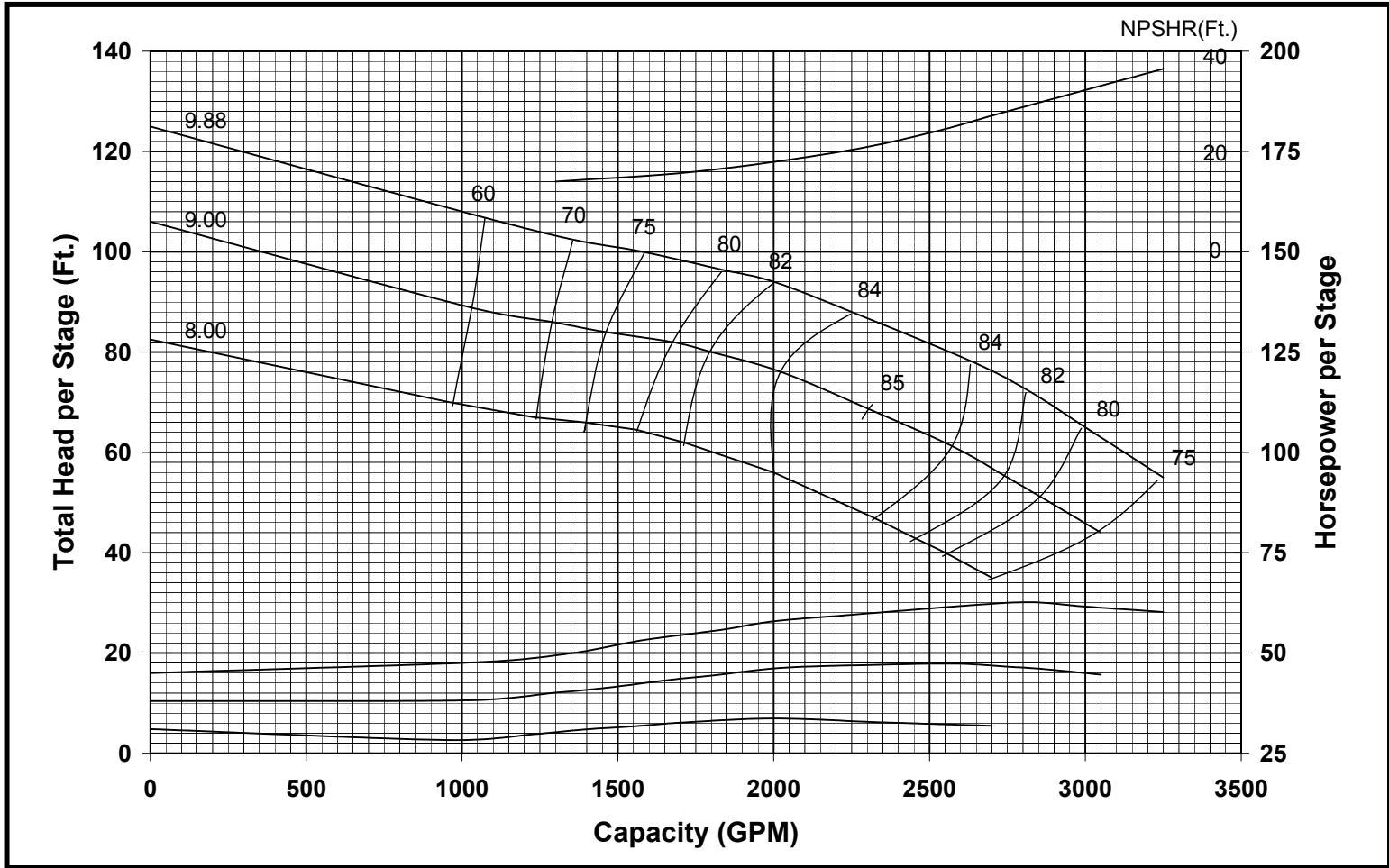
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APPENDIX F

PUMP CURVES

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GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER
PROJECT		SERVICE		GPM CAPACITY	FT. TDH	% EFFICIENCY
						RPM



Curve No.	
E6414RMPC0	
Model	14RHMC
RPM	1770
EFFICIENCY CORRECTION	
1-STAGE	-1.0
2-STAGE	-0.5
3-STAGE	0.0
4-STAGE	0.0
Impeller	ENCLOSED
Ns =	3100
K =	16.0 LBS/FT
K(Bal.)=	N/A
Bowl O.D.	14.0"
Bowl Lateral	0.75"
Max. PSI	327
Disch size	10", 12"
GOULDS PUMPS	
TURBINE OPERATIONS	
Lubbock, Texas	
BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARANTEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.	

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