

CITY OF KALAMAZOO DEPARTMENT OF PUBLIC SERVICES



WATER SYSTEM CORROSION CONTROL IMPROVEMENTS

Bid Set
Project Manual

Prepared by:



TETRA TECH

November 2023

WATER SYSTEM CORROSION CONTROL IMPROVEMENTS

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Performance Bond

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

CONTRACT

Date:
Amount:
Description (Name and Location):

BOND

Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent or representative.

CONTRACTOR AS PRINCIPAL

Company: _____ (Corp. Seal)

Signature: _____
Name and Title:

SURETY

Company: _____ (Corp. Seal)

Signature: _____
Name and Title:
(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

CONTRACTOR AS PRINCIPAL

Company: _____ (Corp. Seal)

Signature: _____
Name and Title:

SURETY

Company: _____ (Corp. Seal)

Signature: _____
Name and Title:

EJCDC No. 1910-28-A (1996 Edition)

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, and the American Institute of Architects.

(FOR INFORMATION ONLY--Name, Address and Telephone)
AGENT or BROKER: _____ OWNER'S REPRESENTATIVE (Engineer or other party): _____

1. The CONTRACTOR and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner for the performance of the Contract, which is incorporated herein by reference.

2. If the CONTRACTOR performs the Contract, the Surety and the CONTRACTOR have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no OWNER Default, the Surety's obligation under this Bond shall arise after:

3.1. The OWNER has notified the CONTRACTOR and the Surety at the addresses described in Paragraph 10 below, that the OWNER is considering declaring a CONTRACTOR Default and has requested and attempted to arrange a conference with the CONTRACTOR and the Surety to be held not later than fifteen days after receipt of such notice to discuss methods of performing the Contract. If the OWNER, the CONTRACTOR and the Surety agree, the CONTRACTOR shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive the OWNER's right, if any, subsequently to declare a CONTRACTOR Default; and

3.2. The OWNER has declared a CONTRACTOR Default and formally terminated the CONTRACTOR's right to complete the Contract. Such CONTRACTOR Default shall not be declared earlier than twenty days after the CONTRACTOR and the Surety have received notice as provided in Paragraph 3.1; and

3.3. The OWNER has agreed to pay the Balance of the Contract Price to:

3.3.1. The Surety in accordance with the terms of the Contract;

3.3.2. Another contractor selected pursuant to Paragraph 4.3 to perform the Contract.

4. When the OWNER has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

4.1. Arrange for the CONTRACTOR, with consent of the OWNER, to perform and complete the Contract; or

4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the OWNER for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by the OWNER and the contractor selected with the OWNER's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the Bonds issued on the Contract, and pay to the OWNER the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by the OWNER resulting from the CONTRACTOR Default; or

4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances;

4.4.1. After investigation, determine the amount for which it may be liable to the OWNER and, as soon as practicable after the amount is determined, tender payment therefor to the OWNER; or

4.4.2. Deny liability in whole or in part and notify the OWNER citing reasons therefor.

5. If the Surety does not proceed as provided in Paragraph 4 with reasonable promptness, the Surety shall be deemed to be in default on this Bond fifteen days after receipt of an additional written notice from the OWNER to the Surety demanding that the Surety perform its obligations under this Bond, and the OWNER shall be entitled to enforce any remedy available to the OWNER. If the Surety proceeds as provided in Paragraph 4.4, and the OWNER refuses the payment tendered or the Surety has denied p liability, in whole or in part, without further notice the OWNER shall be entitled to enforce any remedy available to the OWNER.

6. After the OWNER has terminated the CONTRACTOR's right to complete the Contract, and if the Surety elects to act under Paragraph 4.1, 4.2, or 4.3 above, then the responsibilities of the Surety to the OWNER shall not be greater than those of the CONTRACTOR under the Contract, and the responsibilities of the OWNER to the Surety shall not be greater than those of the OWNER under the Contract. To a limit of the amount of this Bond, but subject to commitment by the OWNER of the Balance of the Contract Price to mitigation of costs and damages on the Contract, the Surety is obligated without duplication for:

6.1. The responsibilities of the CONTRACTOR for correction of defective Work and completion of the Contract;

6.2. Additional legal, design professional and delay costs resulting from the CONTRACTOR's Default, and resulting from the actions or failure to act of the Surety under Paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of the CONTRACTOR.

7. The Surety shall not be liable to the OWNER or others for obligations of the CONTRACTOR that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the OWNER or its heirs, executors, administrators, or successors.

8. The Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and shall be instituted within two years after CONTRACTOR Default or within two years after the CONTRACTOR ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to the Surety, the OWNER or the CONTRACTOR shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the Contract was performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted here from and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

12.1. Balance of the Contract Price: The total amount payable by the OWNER to the CONTRACTOR under the Contract after all proper adjustments have been made, including allowance to the CONTRACTOR of any amounts received or to be received by the OWNER in settlement of insurance or other Claims for damages to which the CONTRACTOR is entitled, reduced by all valid and proper payments made to or on behalf of the CONTRACTOR under the Contract.

12.2. Contract: The agreement between the OWNER and the CONTRACTOR identified on the signature page, including all Contract Documents and changes thereto.

12.3. CONTRACTOR Default: Failure of the CONTRACTOR, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

12.4. OWNER Default: Failure of the OWNER, which has neither been remedied nor waived, to pay the CONTRACTOR as required by the Contract or to perform and complete or comply with the other terms thereof.

(FOR INFORMATION ONLY--Name, Address and Telephone)
AGENT or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):

SECTION 00620 - APPLICATION FOR PAYMENT CERTIFICATE

CONTRACTOR'S APPLICATION FOR PAYMENT NO. _____

CONTRACTOR: _____ TITLE: _____

OWNER: _____ CONTRACT NO.: _____

Substantial Completion Date: _____ Final Completion Date: _____

Milestone Completion Date: _____

Application is made for payment for the Work shown below, accomplished through the date of _____

1. Original Contract Sum		\$	_____
2. Net Change by Change Order		\$	_____
3. Current Contract Amount (line 1 + line 2)		\$	_____
4. Work Complete (from summary sheet)	_____ %	\$	_____
5. Stored Materials (from summary sheet, if applicable)		\$	_____
6. Less _____ % Retainage		\$	_____
7. Less 10% Retainage - Stored Materials		\$	_____
8. Total Retainage (line 6 + 7)		\$	_____
9. Amount Due to Date (line 4 + 5 - 8)		\$	_____
10. Less Previous Payments (from summary sheet)		\$	_____
11. Amount Due This Application (line 9-10)		\$	_____

CONTRACTOR'S Certification:

The undersigned CONTRACTOR certifies that: (1) all previous progress payments received from OWNER on account of Work done under the Contract referred to above have been applied to discharge in full all obligations of CONTRACTOR incurred in connection with Work covered by prior Applications for Payment; (2) title to all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to OWNER at time of payment free and clear of all liens, claims, security interest and encumbrances (except such as are covered by Bond acceptable to OWNER indemnifying OWNER against any such lien, claim, security interest or encumbrance); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and not *defective* as that term is defined in the Contract Documents.

ATTACHMENTS TO THIS CERTIFICATION:

____ Summary Sheet ____ Change Order Summary ____ Stored Material Summary
____ Other _____

CONTRACTOR:

By: _____ Date: _____

Payment to CONTRACTOR of the amount shown in line 11 above is recommended by ENGINEER, Tetra Tech, Inc.

By: _____ Date: _____

APPROVED: OWNER

By: _____ Date: _____

Change Order Summary

No.	Date	Additions	Deductions
	Subtotals		
Total Change In Contract Price			

Stored Material Summary

Invoice No.	Stored Material	Material Location	Insurance Certificates on File	Stored Previous		Stored This Month		Incorporated This Month		Materials remaining in storage (\$)
				Date (MO/YR)	Amount (\$)	Date (MO/YR)	Amount (\$)	Date (MO/YR)	Amount (\$)	
		On-Site Off-Site	Yes / No							
		On-Site Off-Site	Yes / No							
		On-Site Off-Site	Yes / No							

SECTION 00625 - 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.)

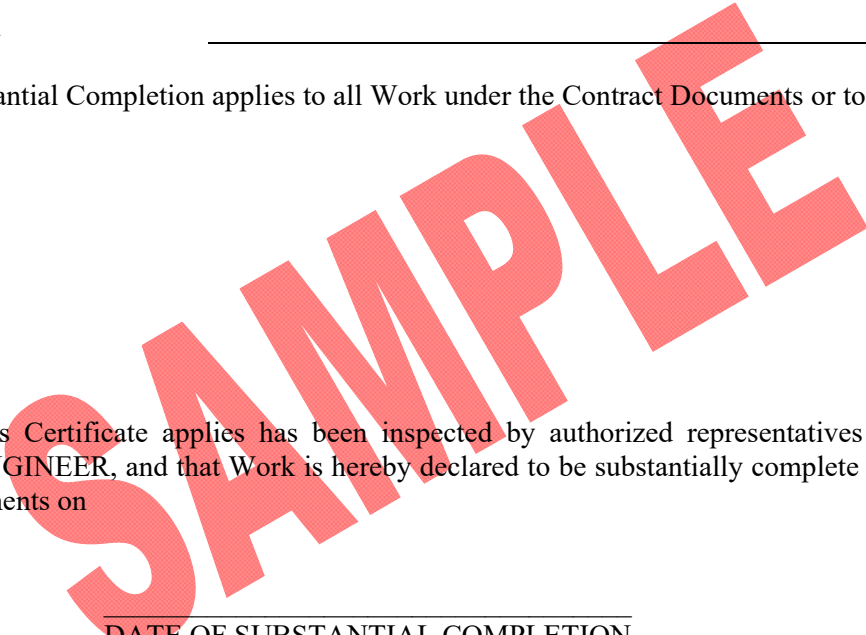
Manufacturer's Representative	Date	Signature
Witnesses:		
Owner's Representative	Date	Signature
Contractor's Representative	Date	Signature
Engineer's Representative	Date	Signature
Owner	Date	Signature

END OF SECTION

SECTION 00626 - CERTIFICATE OF SUBSTANTIAL COMPLETION

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

This Certificate of Substantial 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 substantially complete in accordance with the Contract Documents on

DATE OF SUBSTANTIAL COMPLETION

A tentative 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 within _____ days of the above date of Substantial Completion.

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 List of Items to be completed prior to Final Payment (Pages 1 to __, 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

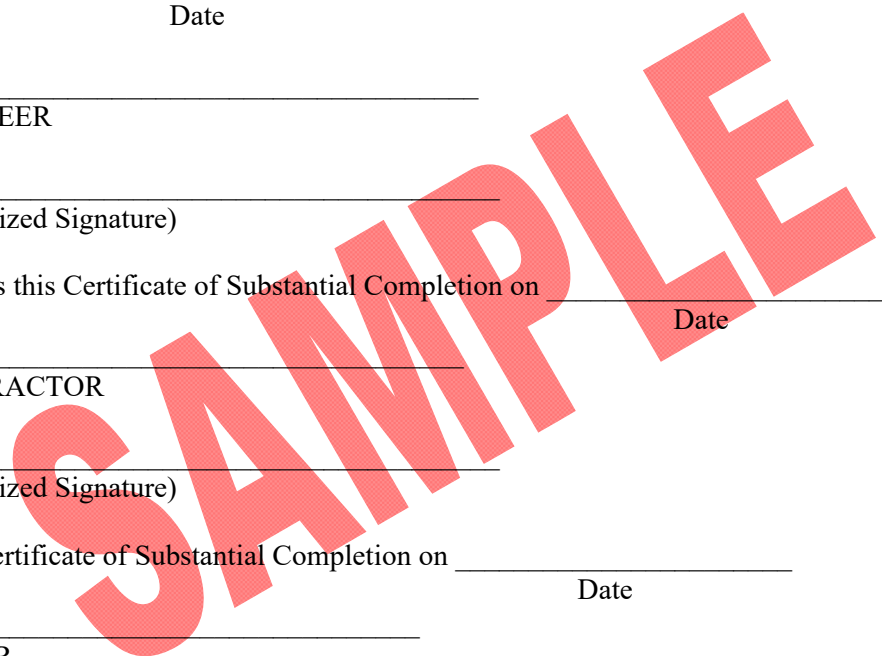
CONTRACTOR

By: _____
(Authorized Signature)

OWNER accepts this Certificate of Substantial Completion on _____
Date

OWNER

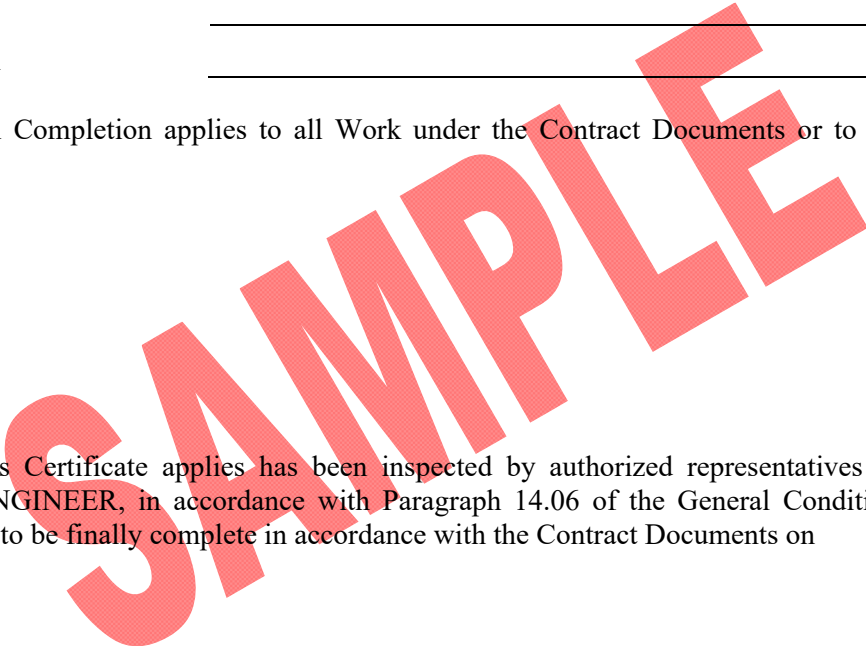
By: _____
(Authorized Signature)



SECTION 00627 - 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, in accordance with Paragraph 14.06 of the General Conditions, 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 _____.

CONTRACTOR's special warranty and guarantee are:

_____ warranty and guarantee period commences on _____ and terminates on _____.

_____ 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

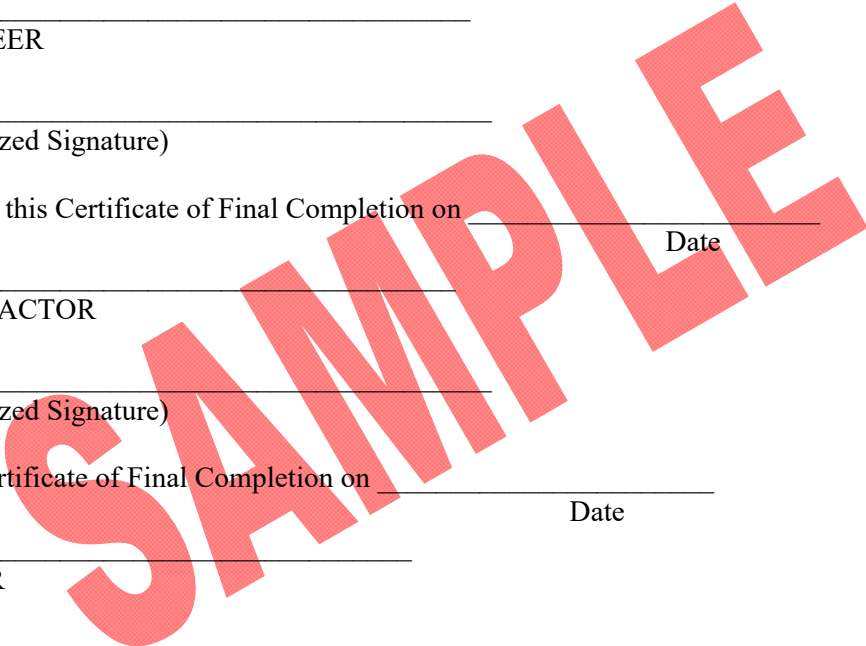
CONTRACTOR

By: _____
(Authorized Signature)

OWNER accepts this Certificate of Final Completion on _____
Date

OWNER

By: _____
(Authorized Signature)



SECTION 00931 - REQUEST FOR INFORMATION

From: _____ RFI Number: _____

Date: _____

Project: _____

Submitted to: _____
ENGINEER - Tetra Tech, Inc. Contract: _____

Specification Section: _____ Paragraph: _____ Drawing Reference: _____ Detail: _____

Request: _____



Attachments
Signed by: _____

Response: _____

Attachments

Follow-up: Contract Clarification Field Order Work Change Directive .Proposal Request

Signed by: _____ Date: _____
ENGINEER - Tetra Tech, Inc.

Copy: OWNER CONTRACTOR RPR CPM Shop Dwg. File

END OF SECTION

SECTION 00942 - FIELD ORDER

CONTRACTOR: _____ F.O. Number: _____

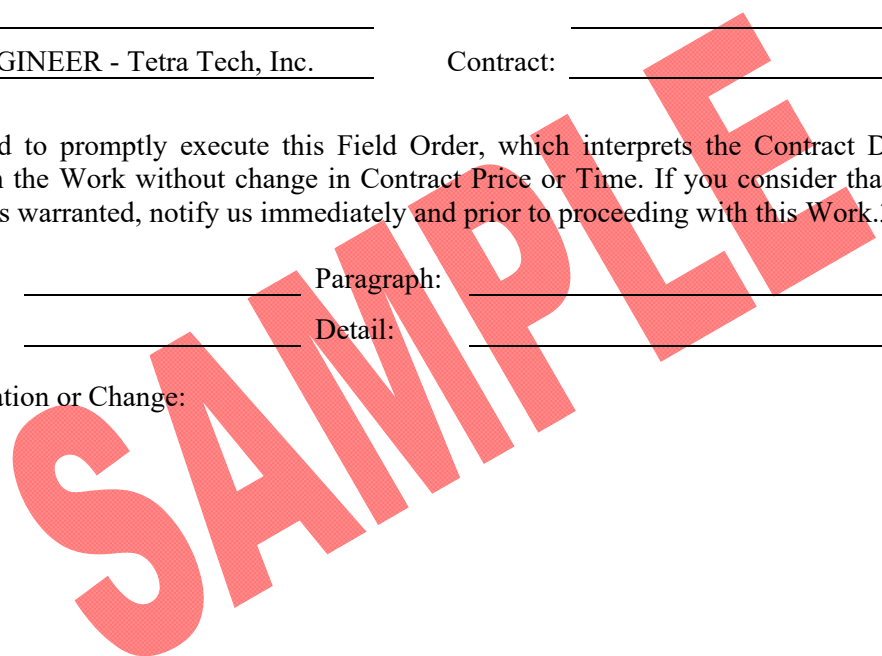
Date: _____

Project: _____
From: _____
ENGINEER - Tetra Tech, Inc. Contract: _____

You are hereby directed to promptly execute this Field Order, which interprets the Contract Documents or orders minor changes in the Work without change in Contract Price or Time. If you consider that a change in Contract Price or Time is warranted, notify us immediately and prior to proceeding with this Work.³

Specification Section: _____ Paragraph: _____
Drawing Reference: _____ Detail: _____

Description of Interpretation or Change: _____



Attachments

Signed by: _____ Date: _____
ENGINEER - Tetra Tech, Inc.

Copy: OWNER CONTRACTOR RPR CPM Shop Dwg. File

END OF SECTION

SECTION 00943 - WORK CHANGE DIRECTIVE

CONTRACTOR: _____ W.C.D. Number: _____

Date: _____
Project: _____
From: _____
ENGINEER - Tetra Tech, Inc. Contract: _____

To prevent a possible delay in the Work you are directed to proceed with the following changes:

Reason:

The Contract Price and/or Contract Times will be adjusted by a future Change Order based on:

- _____ Extension of Unit Prices as indicated in Agreement.
- _____ Actual time and material costs plus OH&P.
- _____ Actual time and material costs plus OH&P, not to exceed. \$ _____
- _____ An agreed sum to be added. \$ _____
- _____ An agreed sum to be deducted. \$ _____
- _____ No change in Contract Price.
- _____ No change in Contract Time.

A detailed breakdown _____ is needed.
_____ has been received.

ENGINEER: Tetra Tech, Inc.

Recommended by: _____ Date _____

CONTRACTOR: _____

Accepted by: _____ Date _____

OWNER: _____

Approved by: _____ Date _____

Copy: OWNER CONTRACTOR RPR CPM Shop Dwg. File

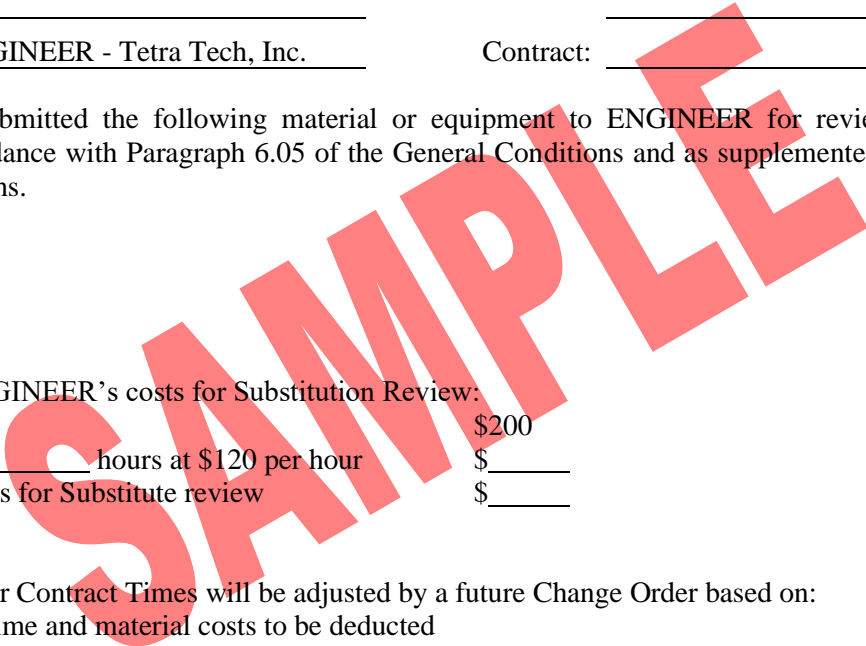
SECTION 00943 - WORK CHANGE DIRECTIVE - SUBSTITUTION

CONTRACTOR: _____ W.C.D. Number: _____

Date: _____

Project: _____
From: _____
ENGINEER - Tetra Tech, Inc. Contract: _____

CONTRACTOR has submitted the following material or equipment to ENGINEER for review as a Substitute item in accordance with Paragraph 6.05 of the General Conditions and as supplemented by the Supplementary Conditions.



Opinion of probable ENGINEER's costs for Substitution Review:
Minimum review fee \$200
Hours to review _____ hours at \$120 per hour \$ _____
Opinion of Probable costs for Substitute review \$ _____

The Contract Price and/or Contract Times will be adjusted by a future Change Order based on:
_____ Actual time and material costs to be deducted

ENGINEER will notify CONTRACTOR if review hours are to exceed those listed above.

Section 01630, Substitution Request Application _____ is needed.
_____ has been received.

ENGINEER: Tetra Tech, Inc. _____

Recommended by: _____ Date _____

CONTRACTOR: _____

Accepted by: _____ Date _____

OWNER: _____

Approved by: _____ Date _____

Copy: OWNER CONTRACTOR RPR CPM Shop Dwg. File

END OF SECTION

SECTION 00946 - CHANGE ORDER

CONTRACTOR: _____ C.O. Number: _____
 _____ Date: _____
 _____ Project: _____

 OWNER: _____ Contract: _____

TO THE CONTRACTOR NAMED ABOVE:
Under the terms of this Agreement, and upon acceptance of CONTRACTOR and approval of OWNER, ENGINEER recommends the following changes to the Agreement:

No.	Description	Add/ Deduct	Amount
			\$
			\$
			\$
TOTAL THIS CHANGE ORDER			

REASON FOR CHANGE:

Current Contract Price	\$ _____
This Change Order Add/Deduct	\$ _____
Revised Contract Price	\$ _____
Current Substantial Completion Date	_____
Current Final Completion Date	_____
Contract Time Extension	_____ Days
Revised Substantial Completion Date	_____
Revised Final Completion Date	_____

The above is agreed to as full and complete compensation for the Work listed in this Change Order.

RECOMMENDED BY: Tetra Tech, Inc.

_____ DATE _____

ACCEPTED BY: CONTRACTOR: _____

_____ DATE _____

APPROVED BY: OWNER: _____

_____ DATE _____

Copy: OWNER CONTRACTOR RPR CPM Shop Dwg. File

END OF SECTION

SECTION 01005 - PROJECT REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. The Work to be done consists of the furnishing of all labor, materials, and equipment, and the performance of all Work included in this Contract. The summary of the Work is presented in Section 01110: Summary of Work.
2. Work Included:
 - a. The Contractor shall furnish all labor, superintendence, materials, power, light, heat, fuel, water, tools, appliances, equipment, supplies, and means of construction necessary for proper performance and completion of the Work. The Contractor shall obtain and pay for all necessary construction permits except as provided for in Section 01065 – Permits and Fees. The Contractor shall perform and complete the Work in the manner best calculated to promote rapid construction consistent with safety of life and property and to the satisfaction of the Engineer, and in strict accordance with the Contract Documents. The Contractor shall clean up the Work and maintain it during and after construction, until accepted, and shall do all Work and pay all costs incidental thereto. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the Work.
 - b. The cost of incidental work described in these Project Requirements, for which there are no specific Contract Items, shall be considered as part of the general cost of doing the Work and shall be included in the prices for the various Contract Items. No additional payment will be made therefore.
 - c. The Contractor shall provide and maintain tools and equipment as may be necessary, in the opinion of the Engineer, to perform in a satisfactory and acceptable manner all the Work required by this Contract. Only equipment of established reputation and proven efficiency shall be used. The Contractor shall be solely responsible for the adequacy of his workmanship, materials, and equipment, prior approval of the Engineer notwithstanding.
3. Public Utility Installations and Structures:
 - a. Public utility installations and structures shall be understood to include all poles, tracks, pipes, wires, conduits, vaults, manholes, and all other appurtenances and facilities pertaining thereto whether owned or controlled by the Owner, other governmental bodies, or privately owned by individuals, firms, or corporations, used to serve the public with transportation, traffic control, gas, electricity, telephone, sewerage, drainage, water, or other public or private property which may be affected by the Work shall be deemed included hereunder.
 - b. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. These data are not guaranteed as to their completeness or accuracy and it is the responsibility of the Contractor to make his own investigations to inform himself fully of the character, condition, and extent of all such installations and structures as may be encountered and as may affect the construction operations.
 - c. The Contractor shall protect all public utility installations and structures from damage during the Work. Access across any buried public utility installation or structure shall be made to avoid any damage to these facilities. All required protective devices and construction shall be provided by the Contractor at his expense. All existing public utilities damaged by the Contractor shall be repaired by the Contractor, at his expense. No separate

payment shall be made for such protection or repairs to public utility installations or structures.

- d. Public utility installations or structures owned or controlled by the Owner or other governmental body which are shown on the Drawings to be removed, relocated, replaced, or rebuilt by the Contractor shall be considered as a part of the general cost of doing the Work and shall be included in the prices bid for the various Contract Items. No separate payment shall be made therefore.
- e. Where public utility installations or structures owned or controlled by the Owner or other governmental body are encountered during the course of the Work, and are not indicated on the Drawings or in the Specifications, and when, in the opinion of the Engineer, removal, relocation, replacement, or rebuilding is necessary to complete the Work under this Contract, such Work shall be accomplished by the utility having jurisdiction, or such Work may be ordered, in writing by the Engineer, for the Contractor to accomplish. If such work is accomplished by the utility having jurisdiction it will be carried out expeditiously, and the Contractor shall give full cooperation to permit the utility to complete the removal, relocation, replacement, or rebuilding as required. If such work is accomplished by the Contractor, it will be paid for as extra work as provided in the Agreement.
- f. The Contractor shall, at all times in performance of the Work, employ acceptable methods and exercise reasonable care and skill so as to avoid unnecessary delay, injury, damage, or destruction of public utility installations and structures; and shall, at all times in the performance of the Work, avoid unnecessary interference with, or interruption of, public utility services, and shall cooperate fully with the owners thereof to that end.
- g. The maintenance, repair, removal, relocation, or rebuilding of public utility installations and structures, when accomplished by the Contractor as herein provided, shall be done by methods approved by the owners of such utilities.

1.02 DRAWINGS AND PROJECT MANUAL

- A. Drawings: When obtaining data and information from the Drawings, figures shall be used in preference to scaled dimensions, and large-scale drawings in preference to small-scale drawings.
- B. Supplementary Drawings:
 - 1. When, in the opinion of the Engineer, it becomes necessary to explain more fully the Work to be done or to illustrate the Work further or to show any changes which may be required, drawings known as Supplementary Drawings, with specifications pertaining thereto, will be prepared by the Engineer, and the Contractor will be furnished one (1) complete set of reproducible drawings (24 inches by 36 inches) and one (1) reproducible copy of the specifications.
 - 2. The Supplementary Drawings shall be binding upon the Contractor with the same force as the Contract Drawings. Where such Supplementary Drawings require either less or more than the estimated quantities of Work, credit to the Owner or compensation therefore to the Contractor shall be subject to the terms of the Agreement.
- C. Contractor to Check Drawings and Data:
 - 1. The Contractor shall verify all dimensions, quantities, and details shown on the Drawings, Supplementary Drawings, Schedules, Specifications, or other data received from the Engineer, and shall notify him of all errors, omissions, conflicts, and discrepancies found therein. Failure to discover or correct errors, conflicts, or discrepancies shall not relieve the Contractor of full responsibility for unsatisfactory work, faulty construction, or improper operation resulting therefrom, nor from rectifying such conditions at his own expense. He will not be allowed to

take advantage of any errors or omissions, as full instructions will be furnished by the Engineer, should such errors or omissions be discovered.

2. All schedules are given for the convenience of the Engineer and the Contractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for the making of estimates of the size, kind, and quality of materials and equipment included in work to be done under the Contract.

D. Specifications: The Technical Specifications consist of three (3) parts: General, Products, and Execution. The General part of a Specification contains General Requirements which govern the Work. The Products and Execution parts modify and supplement the General Requirements by detailed requirements for the Work and shall always govern whenever there appears to be a conflict.

E. Intent:

1. All Work called for in the Specifications applicable to this Contract, but not shown on the Drawings in their present form, or vice versa, shall be of like effect as if shown or mentioned in both. Work not specified in either the Drawings or in the Specifications, but involved in carrying out their intent or in the complete and proper execution of the Work, is required and shall be performed by the Contractor as though it were specifically delineated or described.
2. The apparent silence of the Specifications as to any detail, or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished, shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the best quality is to be used, the interpretation of these Specifications shall be made upon that basis.

1.03 MATERIALS AND EQUIPMENT

A. Manufacturer:

1. All transactions with the manufacturers or subcontractors shall be through the Contractor, unless the Contractor shall request and at the Engineer's option, that the manufacturer or subcontractor deal directly with the Engineer. Any such transactions shall not in any way release the Contractor from his full responsibility under this Contract.
2. Any two (2) or more pieces of material or equipment of the same kind, type, or classification, and being used for identical types of service, shall be made by the same manufacturer.

B. Delivery:

1. The Contractor shall deliver materials in ample quantities to ensure the most speedy and uninterrupted progress of the Work so as to complete the Work within the allotted time.
2. The Contractor shall also coordinate deliveries in order to avoid delay in, or impediment of, the progress of the work of any related Contractor.

C. Tools and Accessories:

1. The Contractor shall, unless otherwise stated in the Contract Documents, furnish with each type, kind, or size of equipment, one (1) complete set of suitably marked high grade special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment. Such tools and appliances shall be furnished in approved painted steel cases, properly labeled and equipped with good grade cylinder locks and duplicate keys.
2. Spare parts shall be furnished as specified herein and as recommended by the manufacturer necessary for the operation of the equipment, not including materials required for routine maintenance.

3. Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, weight, and principal rate data.

D. Service of Manufacturer's Engineer:

1. The Contract Prices for equipment shall include the cost of furnishing a competent and experienced engineer or superintendent who shall represent the manufacturer and shall assist the Contractor, when required, to install, adjust, test, and place in operation, the equipment in conformity with the Contract Documents.
2. After the equipment is placed in permanent operation by the Owner, such engineer or superintendent shall make all adjustments and tests required by the Engineer to prove that such equipment is in proper and satisfactory operating condition, and shall instruct such personnel as may be designated by the Owner in the proper operation and maintenance of such equipment.

1.04 INSPECTION AND TESTING

A. General:

1. For tests specified to be made by the Contractor, the testing personnel shall make the necessary inspections and tests, and the reports thereof shall be in such form as will facilitate checking to determine compliance with the Contract Documents. Five (5) copies of the reports shall be submitted, and authoritative certification thereof must be furnished to the Engineer as a prerequisite for the acceptance of any material or equipment.
2. If, in the making of any test of any material or equipment, it is ascertained by the Engineer that the material or equipment does not comply with the Contract Documents, the Contractor will be notified thereof, and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the site or from the Work and replace it with acceptable material, without cost to the Owner.
3. Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with the recognized test codes of the ANSI, ASME, or the IEEE, except as may otherwise be stated herein.
4. The Contractor shall be fully responsible for the proper operation of equipment during testing and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

B. Costs:

1. All costs for inspections required under the Building Permit shall be provided by the Contractor, unless otherwise expressly specified.
2. The cost of shop and field tests of equipment and of certain other tests specifically called for in the Contract Documents shall be borne by the Contractor, and such costs shall be deemed to be included in the Contract Price.
3. Materials and equipment submitted by the Contractor as the equivalent to those specifically named in the Contract may be tested by the Owner for compliance. The Contractor shall reimburse the Owner for the expenditures incurred in making such tests of materials and equipment which are rejected for non-compliance.

C. Certificate of Manufacture:

1. Contractor shall furnish to Engineer authoritative evidence in the form of a certificate of manufacture that the materials to be used in the Work have been manufactured and tested in conformity with the Contract Documents.

2. These certificates shall be notarized and shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

D. Shop Tests:

1. Each piece of equipment for which pressure, duty, capacity, rating, efficiency, performance, function, or special requirements are specified shall be tested in the shop of the maker in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents. Shop tests where specified shall be witnessed by the Engineer.
2. Five (5) copies of the manufacturer's actual test data and interpreted results thereof, accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company and/or independent laboratory, shall be submitted to the Engineer for approval.
3. The cost of shop tests, travel expenses of the Engineer, and of furnishing manufacturer's preliminary and shop test data of operating equipment shall be borne by the Contractor.

E. Start-up Tests:

1. As soon as conditions permit, the Contractor shall furnish all labor, materials, and instruments and shall make start-up tests of equipment.
2. If the start-up tests disclose any equipment furnished under this Contract which does not comply with the requirements of the Contract Documents, the Contractor shall, prior to demonstration tests, make all changes, adjustments, and replacements required. The furnishing Contractor shall assist in the start-up tests as applicable.

F. Demonstration Tests:

1. Prior to Contractor's request for a Substantial Completion inspection, all equipment and piping installed under this Contract shall be subjected to demonstration tests as specified or required to prove compliance with the Contract Documents.
2. The Contractor shall furnish labor, fuel, energy, water, and all other materials, equipment, and instruments necessary for all demonstration tests, at no additional cost to the Owner. Contractor shall assist in the demonstration tests as applicable.

1.05 LINES AND GRADES

A. Grade:

1. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings, or as given by the Engineer. The full responsibility for keeping alignment and grade shall rest upon the Contractor.
2. The Engineer will establish benchmarks and baseline controlling points. Reference marks for lines and grades as the Work progresses will be located by the Contractor to cause as little inconvenience to the prosecution of the Work as possible. The Contractor shall so place excavation and other materials as to cause no inconvenience in the use of the reference marks provided. He shall remove any obstructions placed by him contrary to this provision.

B. Surveys:

1. The Contractor shall furnish and maintain, at his own expense, stakes and other such materials.
2. The Contractor shall check such reference marks by such means as he may deem necessary and, before using them, shall call the Engineer's attention to any inaccuracies.

3. The Contractor shall, at his own expense, establish all working or construction lines and grades as required from the reference marks set by the Engineer, and shall be solely responsible for the accuracy thereof. He shall, however, be subject to the check and review by the Engineer.

C. Safeguarding Marks:

1. The Contractor shall safeguard all points, stakes, grade marks, monuments, and bench marks made or established on the Work, bear the cost of re-establishing them if disturbed, and bear the entire expense of rectifying work improperly installed due to not maintaining or protecting or to removing without authorization such established points, stakes, and marks.
2. The Contractor shall safeguard all existing and known property corners, monuments, and marks adjacent to but not related to the Work and shall bear the cost of re-establishing them if disturbed or destroyed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01065 - PERMITS AND FEES

PART 1 -- GENERAL

- A. The Contractor shall secure and pay for all permits and licenses related to his work, including but not limited to, necessary construction permits as provided for in Section 00100: General Conditions except as otherwise provided herein.
- B. The Contractor shall procure all necessary permits and licenses, pay all charges and fees, and give all notices necessary and incidental to the due and lawful prosecution of the work. The Contractor shall determine what permits are required for construction of the Work and procure them.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 01070 - STANDARDS AND ABBREVIATIONS

PART 1 - GENERAL

1.01 STANDARDS AND ABBREVIATIONS

- A. Referenced Standards: Any reference to published specifications or standards of any organization or association shall comply with the requirements of the specification or standard which is current on the date of Advertisement for Bids. In case of a conflict between the referenced specifications or standards, the one having the more stringent requirements shall govern.
- B. Reference in the specifications to MDOT Standards shall mean the “MDOT 2012 Standard Specifications for Construction”.
- C. In case of conflict between the referenced specifications or standards and the Contract Documents, the Contract Documents shall govern.
- D. Abbreviations:

AA	Aluminum Association
AAA	American Arbitration Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	The American Association of State Highway and Transportation Officials
ABA	American Bar Association
ABMA	American Boiler Manufacturers Association
ABPA	Acoustical and Board Products Association
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies
AFBMA	Anti-Friction Bearing Manufacturers Association
AF&PA	American Forest & Paper Association
AGA	American Gas Association
AGC	Associated General Contractors of America
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AIA	American Insurance Association
AIEE	American Institute of Electrical Engineers (Now IEEE)
AIMA	Acoustical and Insulating Materials Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standard Institute
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association
AREA	American Railway Engineering Association
ARI	American Refrigeration Institute

ASA	American Standards Association (Now ANSI)
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSCBC	American Standard Safety Code for Building Construction
ASSHTO	American Association of State Highway Transportation Officials
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWPB	American Wood Preservers Bureau
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America (formerly SCPI)
CDA	Copper Development Association
CFR	Code of Federal Regulations
CFS	Cubic Feet Per Second
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standard
CSA	Canadian Standards Association
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
DOT Spec	Standard Specification for Road and Bridge Construction Florida Department of Transportation
E/A	Engineer and/or Architect
EDA	Economic Development Association
EEI	Edison Electric Institute
EPA	Environmental Protection Agency
FCI	Fluid Control Institute
Fed Spec	Federal Specification
FM	Factory Mutual Engineering and Research
FPS	Feet Per Second
FS	Federal Standards
GPM	Gallons Per Minute
HMI	Hoist Manufacturers Institute
HI	Hydraulic Institute
HP	Horsepower
HSBII	Hartford Steam Boiler Inspection and Insurance Co.
ID	Inside Diameter
IEEE	Institute of Electrical and Electronic Engineers
IFI	Industrial Fasteners Institute
IPCEA	Insulated Power Cable Engineers Association
IPS	Iron Pipe Size
ISA	Instrument Society of America
MBMA	Metal Building Manufacturers Association
MDEQ	Michigan Department of Environmental Quality

MDOT	Michigan Department of Transportation
MGD	Million Gallons Per Day
MHI	Materials Handling Institute
MMA	Monorail Manufacturers Association
MIOSHA	Michigan Occupational Safety and Health Administration
NAPA	National Asphalt Pavement Association
NBFU	National Board of Fire Underwriters
NBHA	National Builders' Hardware Association
NBS	National Bureau of Standards
NCPI	National Clay Pipe Institute
NCSA	National Crushed Stone Association
NCSPA	National Corrugated Steel Pipe Association
NEC	National Electrical Code
NECA	National Electrical Contractors' Association
NEMA	National Electrical Manufacturers' Association
NFPA	National Fire Protection Association
NLA	National Lime Association
NPC	National Plumbing Code
NPCA	National Precast Concrete Association
NPT	National Pipe Threads
NSC	National Safety Council
NSF	National Sanitation Foundation
OD	Outside Diameter
OSHA	U.S. Department of Labor, Occupational Safety and Health Act
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PS	United States Products Standards
PSI	Pounds per Square Inch
PSIA	Pounds per Square Inch Absolute
PSIG	Pounds per Square Inch Gauge
PTI	Post Tensioning Institute
RPM	Revolutions Per Minute
SAE	Society of Automotive Engineers
SDI	Steel Decks Institute
SJI	Steel Joists Institute
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SSI	Scaffolding and Shoring Institute
SSPC	Steel Structures Painting Council
SSPC	Structural Steel Painting Council
STA	Station (100 feet)
TDH	Total Dynamic Head
TH	Total Head
TPI	Truss Plate Institute
UBC	Uniform Building Code
UL	Underwriter's Laboratories, Inc.
USACE	United States Army Corps of Engineers
USASI or	United States of America Standards Institute

C. Additional abbreviations and symbols are shown on the Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01110 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. The Work to be performed shall consist of furnishing tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including but not limited to fuel, power, water, essential communications, and performing all Work or other operations required in strict accordance with the Drawings and these specifications. The Work shall be complete, and all Work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the Work in good faith shall be provided by CONTRACTOR as though originally so indicated, at no increase in cost to OWNER.
- B. The Project is located at twelve pump stations distributed throughout the City of Kalamazoo Public Water Supply System. The pump station addresses are as follows:
1. Pump Station 1 - 215 W Stockbridge, Kalamazoo, MI 49001
 2. Pump Station 3 - 331 Balch St Kalamazoo, MI 49001
 3. Pump Station 4 - 2000 W Crosstown Pkwy Kalamazoo, MI 49008
 4. Pump Station 8 - 200 E Kilgore Rd Kalamazoo, MI 49001
 5. Pump Station 9 - 813 W Kilgore Rd Kalamazoo, MI 49008
 6. Pump Station 11 - 432 Kendall Ave Kalamazoo, MI 49006
 7. Pump Station 12 - 3000 Stadium Dr Kalamazoo, MI 49008
 8. Pump Station 14 - 2300 Henson Kalamazoo, MI 49048
 9. Pump Station 22 - 4419 Siesta St Kalamazoo, MI 49009
 10. Pump Station 24 - 5999 South 9th St Kalamazoo, MI 49009
 11. Pump Station 25 - 7275 East H Ave Kalamazoo, MI 49048
 12. Pump Station 39 - 8801 Miller Dr Galesburg, MI 49053
- C. The Work consists generally of corrosion control system improvements at each of the pump stations. Existing sodium hexametaphosphate and poly-orthophosphate storage and feed systems will be removed and replaced with new poly-orthophosphate storage and feed systems. Each system will typically include a chemical fill station, chemical storage tank with level sensor, chemical transfer pump, day tank with load scale, chemical feed pump, chemical feed piping/tubing, and phosphate analyzer. Several stations will not require a transfer pump and day tank and chemical will be fed directly from the storage tank in these locations.

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 and its ability to maintain adequate supply of drinking water and fire protection. In order to meet the overall objective of this Project, certain elements of the Work must be completed in a particular sequence. It may also be necessary to do certain parts of the Work outside normal working hours. CONTRACTOR shall do this Work at such times and at no additional cost to OWNER. CONTRACTOR shall be completely responsible for fines and other enforcement imposed upon the facility resulting from inadvertent or unplanned interruptions caused by CONTRACTOR. A suggested sequence of construction is as follows:
1. CONTRACTOR shall coordinate the installation of SCADA components with OWNER's Process Control Supervisor, Brian Stygar.

2. CONTRACTOR shall coordinate the demolition of and installation of chemical storage and feed components with the OWNER's representative.
 3. Work may be conducted concurrently at multiple pump stations, but a maximum of one pump station shall be removed from service at any given time. Pump Station Nos. 22 and 24 are the only two stations serving the City's super-high pressure district. Work at these two stations must be coordinated to avoid any risk of a concurrent outage.
 4. Existing chemical storage and feed systems shall remain operational until startup of new system. OWNER will feed as much stored liquid phosphate product as possible prior to startup of new system. Remaining liquid sodium hexametaphosphate and liquid poly-orthophosphate product may be landfill disposed by CONTRACTOR. Under no circumstances shall any chemical be disposed to surface waters, sanitary sewer, or wastewater treatment plant.
 5. CONTRACTOR shall coordinate startup and water quality sampling with OWNER prior to water with new chemical being sent to system.
- B. If CONTRACTOR wishes to propose an alternate sequence of construction for maintaining operation of existing facilities, CONTRACTOR shall submit complete details of its plan to ENGINEER for approval.

1.03 CONTRACTOR USE OF PREMISES

- A. Limit use of the premises to construction activities in areas indicated; allow for OWNER occupancy and use by the public. 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 private property owners 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. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.04 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. 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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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.
- B. Unit-cost Allowance: A specified quantity of a product or assembly, as part of the Contract Price, that is to be included in the Work even though the location of the product or assembly is not indicated on Drawings or shown in the specifications.
- C. Contingency Allowance: A monetary sum that, as part of the Contract Price, is to be utilized as directed by OWNER, through a Change Order, to cover minor changes in the Work.
- D. Provisionary Allowance: A monetary sum that, as part of the Contract Price, is to be utilized as directed by OWNER, through a Change Order, to cover minor changes in the Work.

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.
- 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 Tree Trimming. CONTRACTOR shall arrange for, manage, and be responsible for the cost of trimming tree limbs directly above and within 5-feet of each side of site access drives from the road right-of-way to the chemical fill station to a minimum clear height of 15-feet. This work may be required at each pump station planned for improvements under this contract. This work is not shown on Drawings. An Allowance of \$ 10,000 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. CONTRACTOR shall submit invoices for this work with payment applications.

2. Lump Sum Allowance for PS 8 Sanitary Connection, City of Portage. CONTRACTOR to coordinate and pay all required sewer connection fees to the City of Portage for the sanitary connection at Pump Station 8. An Allowance of \$15,000 shall be included in the Contract Price for this Work. Contractor's time associated with Coordination with the agencies for the purposes of obtaining the permits shall not be included in this allowance. An itemization of the permit fees shall accompany the pay request. A mark-up on this work is not allowed.

END OF SECTION

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. Specification Sections referenced on the Schedule contain requirements for materials and methods necessary to achieve the Work described under each Alternate. Drawings referenced on the Schedule indicate the Work required to perform the Alternate.
- 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: Special Coatings (Chemical resistant and slip resistant floor coatings) shall be provided within the limits shown on the Drawings. All costs related to application of special coatings shall be included. Work includes but is not limited to temporary equipment relocation, cleaning, existing coating removal, surface preparation, protection of surroundings, atmospheric control, and application of special coatings in accordance with Section 09960 Special Coatings.

Reference Drawing Nos. D-101 through D-124, and Specification Section 09960 Special Coatings.

Alternate No. 2

Description: Miscellaneous removals, replacement, and repairs shall be provided as noted on the Drawings. All costs related to the items noted shall be included. Work includes the following items:

Pump Station No. 3:

Removal and replacement of a door and louver.

Pump Station No. 8:

Cleaning and coating the exterior steel column.

Pump Station No. 9:

Cleaning and coating the exterior railing and handrail.

Removing delaminated concrete and patching of exterior dock wall by the stairs.

Removing delaminated concrete and patching of the edge of the dock.

Pump Station No. 12:

Remove and replace concrete stairs.

Cleaning and coating the exterior railing and handrail.

Add aluminum handrail to the exterior stairs.

Pump Station No. 14:

Cleaning and coating the exterior steel columns.

Pump Station No. 25:

Cleaning and coating the exterior doors.

Reference Drawing No. S-102, S-103, S-106, S-109, S-112, S-113, S-115, S-122 and Specification Section 02225 Selective Demolition, 03930 Repair Existing Concrete Structures, 05521 Pipe and Tube Railings, 09900 Painting.

Alternate No. 3

Description: Steel hoist system removal shall be completed as noted on the Drawings. All costs related to removing the hoist, its steel supports, and electrical power and removing and replacing the door where the hoist beam penetrates.

Reference Drawing No. S-123 and S-124, and Specification Section 02225 Selective Demolition.

END OF SECTION

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 Application for Payment form is included in Section 00620.
 - 2. 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.
- 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. 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. Use the pay application form included in Section 00620 for Applications for Payment.
 5. 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.
 6. Entries shall match data on Schedule of Values and CONTRACTOR's Construction Schedule. Use updated Schedules if revisions have been made.
 7. Include amounts of Change Orders and Work Change Directives issued prior to the last day of the construction period covered by the application.
 8. Submit 3 executed copies of each Application for Payment to ENGINEER; 1 copy shall be complete, including waivers of lien and similar attachments, when required.
 9. 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. Warranties (guarantees) and maintenance agreements.
 - b. Maintenance instructions.
 - c. Meter readings.
 - d. Final cleaning.
 - e. Final progress photographs.

- f. 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. 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 surplus materials, rubbish, and similar elements.

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. Coordination with other Contractors.
 - 3. Administrative and supervisory personnel.
 - 4. Land survey work.
 - 5. Pre-Construction Conference.
 - 6. Pre-Excavation Conference.
 - 7. Progress meetings.
 - 8. General installation provisions.
 - 9. Cleaning and protection.
- B. Related Sections Specified Elsewhere:
 - 1. Requirements for CONTRACTOR's Construction Schedule are included in Section 01330.

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.
- B. 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.

- C. 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.

- D. 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 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.

1.06 PRE-EXCAVATION CONFERENCE

- A. In addition to the Pre-Construction Conference, ENGINEER may also require a Pre-Excavation Conference in relation to the installation of the direct buried antenna towers. CONTRACTOR and Subcontractors performing excavation Work on Site shall provide written descriptions of their plans for shoring, dewatering, disposal of spoils, protection of existing utilities, and any other particulars of the excavation process, including the technical basis for their selection of the means and methods to be employed. ENGINEER will prepare and distribute minutes.

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.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 LAND SURVEY WORK

- A. CONTRACTOR Performance:
 - 1. Furnish stakes and such suitable labor and assistance as ENGINEER may require in setting survey work.

2. Be responsible for costs by ENGINEER for providing:
 - a. Additional or replacement staking of original control points established by ENGINEER.
 - b. Replacements of Site benchmarks established by ENGINEER.
3. 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.
4. Working from lines and levels established by ENGINEER, establish benchmarks and markers to set lines and levels at each area of Work and elsewhere as needed to properly locate each element of the Project. Calculate and measure required dimensions within indicated or recognized tolerances. Do not scale Drawings to determine dimensions.
5. Benchmarks or control points shall not be changed or relocated without prior written approval by ENGINEER. Promptly report lost or destroyed reference points, or requirements to relocate reference points because of necessary changes in grades or locations.
6. Promptly replace lost or destroyed Project control points. Base replacements on the original survey control points.
7. Advise entities engaged in construction activities, of marked lines and levels provided for their use.
8. As construction proceeds, check every major element for line, level and plumb.
9. 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.
10. 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.
11. 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.

3.03 PIPE LOCATIONS

- A. All pipes shall be located substantially as indicated on the Drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

3.04 OPEN EXCAVATIONS

- A. Contractor shall adequately safeguard all open excavations by providing temporary barricades, caution signs, lights, and other means to prevent accidents to persons, and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by workmen. All open excavations shall comply with applicable OSHA Standards.

3.05 TEST PITS

- A. Test pits for the purpose of locating underground pipelines or structures in advance of the construction shall be excavated and backfilled by the Contractor. Test pits shall be backfilled immediately after their purpose has been satisfied and maintained in a manner satisfactory to the Engineer. The costs for such test pits shall be borne by the Contractor.

3.06 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property, and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before the damage was done, or he shall make good the damage in other manner acceptable to the Engineer.

3.07 PROTECTION OF CONSTRUCTION AND EQUIPMENT

- A. All newly constructed work shall be carefully protected from damage in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions damaged shall be reconstructed by the Contractor at no additional expense to the Owner.
- B. Protect all structures in a suitable manner to prevent damage. Should any part of a structure become heaved, cracked or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor at his own expense and to the satisfaction of the Engineer. If, in the final inspection of the work, any defects, faults or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the guarantee period described in the Contract.
- C. Further, the Contractor shall take all necessary precautions to prevent damage to any structure due to water pressure during and after construction and until such structure is accepted and taken over by the Owner.

3.08 MAINTENANCE OF TRAFFIC

- A. Unless permission to close a street is received in writing from the proper authority (County, City, MDOT, etc.), all excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Engineer.
- B. Detours around construction will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the Contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured will be strictly controlled by the Owner. All maintenance of traffic plans required for construction shall be approved by the local governmental entity having jurisdiction.
- C. The Contractor shall take precautions to prevent injury to the public due to open trenches. Night watchmen may be required where special hazards exist, or police protection provided for traffic while work is in progress. The Contractor shall be fully responsible for damage or injuries whether or not police protection has been provided.

3.09 PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside the site, except by written permission of the appropriate Owners. Contractor shall provide Owner a copy of such written permission prior to entering private land.

3.10 COOPERATION WITHIN THIS CONTRACT

- A. The Contractor shall, prior to interrupting a utility service (water, sewer, etc.) for the purpose of making cut-ins to the existing lines or for any other purposes, contact the Owner and make arrangements for the interruption, which will be satisfactory to the Owner.

3.11 COOPERATION WITH OTHER CONTRACTS

- A. This Contract may require a portion of the work to be connected to work done under other contract(s). It will be necessary for the Contractor to plan his work and cooperate with other contractors insofar as possible to prevent any interference and delay.

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.

1.02 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.

1.03 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.

1.04 CONSTRUCTION SCHEDULE

A. Bar Chart Schedule:

1. Prepare a fully developed, horizontal bar chart type Construction Schedule. Submit within 30 days of the date established for "Commencement of the Work."

2. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated on Schedule of Values.
 3. Prepare Schedule on a sheet, or series of sheets, of stable transparency or other reproducible media, of sufficient width to show data for the entire construction period.
 4. 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.
 5. Coordinate Construction Schedule with Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
 6. 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.

1.05 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 2 weeks following the meeting or activity.

1.06 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. Manufacturer's catalog sheets, brochures, diagrams, illustrations, and other standard descriptive data shall be clearly marked to identify pertinent materials, products, or models. Delete information which is not applicable to the Work by striking or cross-hatching.
- 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.

1.07 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.

1.08 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.

1.09 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.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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.

1.02 OPERATION AND MAINTENANCE

- A. All equipment suppliers shall submit to ENGINEER, through CONTRACTOR, 4 bound copies and 1 electronic/digital format copy of a manual containing specifications, Drawings, and descriptions of equipment; installation instructions; operation, maintenance, and lubrication manuals; parts lists; emergency instructions; and where applicable, test data with curves, wiring diagrams, PLC programs, VFD configuration, Valve actuator configuration on CD and schematics. This information shall be submitted for each item of equipment furnished under this Contract and shall be specific to the exact equipment models complete with all appurtenances provided. It shall also include detailed, comprehensive directions for all required maintenance activities and for the repair or replacement of all wearing parts. Special attention shall be paid to necessary safety precautions that OWNER's staff should take when operating, maintaining, or repairing the equipment.

1. Bound copies of O&M Manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after ENGINEER has given final approval of Shop Drawings. All manuals shall be submitted to ENGINEER following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by ENGINEER. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.
2. Electronic Copy of O&M Manuals: Each equipment O&M manual shall be provided with an electronic disk, matching the content of the final approved printed O&M Manual. The information shall be saved in a single ".pdf" file, with bookmarks for each chapter, section, appendices, etc., as well as each piece of equipment. Where numerous pieces of equipment may be addressed within a section, a second tier of bookmarks shall be provided to allow quick access to each piece of equipment or key piece of information.
3. "Sample" Table of Contents:

Bookmarks

Table of Contents

Section 1 - Approved Shop Drawings

Section 2 - Installation Instructions and Parts Identification

Section 3 - Operations and Maintenance Information

Section 4 - Troubleshooting (If not included in Section 3.)

Section 5 - Parts List (If not included in Section 3.)

Section 6 - Lubrication Instructions (If not included in Section 3.)

4. These manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after ENGINEER has given final approval of Shop Drawings. All manuals shall be submitted to ENGINEER following final Shop Drawing approval and prior to the date of

shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by ENGINEER. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.

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 stainless steel or aluminum-clad sheet steel or 1/2-inch mesh stainless steel 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 stainless steel.
 - 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 LED Lamps, 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. Sluice gates shall be factory painted with coal tar.
- C. The exterior surfaces of all ground-buried valves shall receive a coal tar or bituminous coating in accordance with manufacturer's standards. The inside surfaces of all valves shall be coated with coal-tar pitch varnish in accordance with the latest AWWA Specifications.
- D. 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.
- E. Where specified, steel and iron surfaces shall be hot-dipped galvanized in conformity with ASTM A 153 and A 385.
- F. 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 caulked with lead and oakum or be mechanical joint.

3.03 EQUIPMENT INSTALLATION CHECK

- 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, once prior to installation to review installation procedures with CONTRACTOR and once after installation to inspect, check, adjust if necessary, and approve the equipment's installation. 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 ENGINEER.
- 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, through ENGINEER, a written report 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 connecting piping or anchor bolts;
 - 4. Has been operated under full load condition and that it operated satisfactorily to ENGINEER;
 - 5. That OWNER's Representative has 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.

3.04 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.
 - 1. Manufacturer's representative shall provide a minimum of 2 on-Site training sessions.
 - a. Two sessions for Maintenance personnel
 - 2. Review operating and maintenance data contained in the final approved operating and maintenance manuals.
 - 3. Schedule training with OWNER, provide at least 10-day prior written notice to ENGINEER and OWNER.

END OF SECTION

SECTION 01650 - START-UP AND DEMONSTRATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Demonstrate to Owner and Engineer that the Work functions as a complete and operable system under normal and emergency operating conditions for each of the constructed sites of this contract. Each site shall undergo a separate start-up and demonstration period.
- B. Contractor shall provide all materials, personnel, equipment and expendables as needed and as specified to perform the required start-up and demonstration tests.
- C. Related Work Described Elsewhere:
 - 1. Progress Schedules: Section 01310.
 - 2. Chemical Feed Pumps: Section 11243
 - 3. Chemical Storage Tanks: Section 13205
 - 4. Instrumentation: Division 13.
 - 5. Mechanical: Division 15.
 - 6. Electrical: Division 16.

PART 2 - PRODUCTS

2.01 START-UP PLAN

- A. Submit for approval by the Engineer a detailed start-up plan outlining the schedule and sequence of all tests and start-up activities, including submittal of checkout forms, submittal of demonstration test procedures, start-up, demonstration and testing, submittal of certification of completed demonstration and training. Start-up and commissioning may not begin until the plan is approved by the Engineer.

PART 3 - EXECUTION

3.01 COMPONENT TEST AND CHECK-OUT

- A. Start-up Certification: Prior to system start-up, successfully complete all the testing required of the individual components of the Work. Submit six (6) copies of check out forms for each individual component or piece of equipment, signed by the Contractor or the subcontractor and the manufacturer's representative. All copies of the Operation and Maintenance Manuals must be provided before start-up may begin. These forms shall be completed and submitted before Instruction in Operation to Owner or a request for initiating any final inspections. Insert one (1) copy of this form into the applicable section of each Operation and Maintenance Manual.
- B. Demonstrate to the Engineer and the Owner's representative, that all temporary jumpers and/or bypasses have been removed and that all of the components are operating under their own controls as designated.

- C. Coordinate start-up activities with the Owner's operating personnel and with the Engineer prior to commencing system start-up.
- D. The Contractor shall furnish and pay for all power, water, fuels, oil, grease, chemicals, and auxiliaries that are required for conducting the Contractor's testing of the equipment for proper operation, efficiency, and capacity during Pre Start Up.
 - 1. Contractor shall use Carus 8700 for Pre Start Up of chemical systems as described in Section 11243.

3.02 START-UP

- A. Confirm that all equipment is properly energized.
- B. Initiate start-up and training in accordance with the use of the operation and maintenance manuals.
- C. Observe the component operation and make adjustments as necessary to optimize the performance of the Work.
- D. Coordinate with Owner for any adjustments desired or operational problems requiring debugging.
- E. Make adjustments as necessary.
- F. The Contractor shall furnish and pay for all power, water, fuels, oil, grease, chemicals, and auxiliaries that are required for conducting the Contractor's testing of the equipment for proper operation, efficiency, and capacity during System Start Up.
 - 1. Contractor shall supply the Carus 8700 product in sufficient quantity to start up, test operate and successfully demonstrate the operation, monitoring and control functions of all the chemical feed system equipment installed at each location.

3.03 START-UP DEMONSTRATION AND TESTING (PER SITE, 12 TOTAL SITES)

- A. After all Work components have been constructed, field tested, and started up in accordance with the individual Specifications and manufacturer requirements, and after all Check-Out Forms have been completed and submitted, perform the Start-Up Demonstration and Testing. The demonstration period shall be held upon completion of all systems at a starting date to be agreed upon in writing by the Owner or his representative. Prior to beginning the start-up demonstration testing, the Contractor shall submit a detailed schedule of operational circumstances for approval by the Engineer. The schedule of operational circumstances shall describe, in detail, the proposed test procedures for each piece of equipment. Provide similar test procedure forms for each piece of equipment or section of the Work to include all particular aspects and features of that equipment or section of the Work and as specified in the Technical Sections of the Specifications.
- B. The Start-Up Demonstration Testing will be conducted for three (3) consecutive days. The Work must operate successfully during the three (3) day testing period in the manner intended. If the Work does not operate successfully, or if the start-up is interrupted due to other contracts, the problems shall be corrected and the test shall start over from day one. The party causing the interruption shall be subject to the assessment of actual damages due to delay.
- C. During the start-up demonstration period, operate the Work, instruct designated personnel in the function and operation of the Work, and cause various operational circumstances to occur. As a minimum, these circumstances will include performance standards, random equipment or process

failures, interlocks and bypasses. Demonstrate the essential features of the equipment and its relationship to other equipment. The approved schedule of operational circumstances and demonstration test procedures will be used as the agenda during the Start-Up Demonstration Testing period for all equipment and sections of the Work. Coordination of the demonstration test schedule will be accomplished through the Engineer.

- D. Acceptability of the Work's performance will be based on the Work performing as specified under these actual and simulated operating conditions functioning as intended and as defined in the Contract Documents. The intent of the start-up demonstration and testing is for the Contractor to demonstrate to the Owner and the Engineer that the Work will function as a complete and operable system under normal, as well as emergency operating conditions, and is ready for final acceptance.
- E. Demonstrate the essential features of all electrical and instrumentation systems including, but not limited to, the following as they apply to the work:
 - 1. Electrical system controls and equipment.
 - 2. Chemical storage and feed systems.
 - 3. Mechanical systems.
 - 4. Communications systems.
 - 5. Wiring devices.
 - a. Outlets: convenience, special purpose.
 - b. Switches: regular, time.
- F. Upon successful completion of the Start-up, Demonstration and Testing, the Owner's personnel will receive the specified training for each system. Training of the Owner's personnel will not be considered valid unless it takes place using a system that has successfully passed the Start-up, Demonstration and Testing.
- G. Upon completion of all specified operator training, the Contractor shall submit to the Engineer six (6) copies of the Certificate of Completed Demonstration Form, for each item of equipment or system in the Work, signed by the Contractor, Subcontractor, Engineer, and the Owner. Insert one (1) copy of this form in the applicable section of each Operation and Maintenance Manual. Samples of the Check Out Form and Certificate of Completed Demonstration Form are provided at the end of this Section.

CHECK OUT FORM

<input type="checkbox"/>	OWNER	<u>City of Kalamazoo</u>	No. Copies	_____	CHECK-OUT
<input type="checkbox"/>	ENGINEER:	<u>Tetra Tech</u>	No. Copies	_____	MEMO NO. _____
<input type="checkbox"/>	ARCHITECT:	_____	No. Copies	_____	
<input type="checkbox"/>	CONTRACTOR:	_____	No. Copies	_____	
<input type="checkbox"/>	FIELD:	_____	No. Copies	_____	
<input type="checkbox"/>	OTHER:	_____	No. Copies	_____	

PROJECT DATA

CONTRACT DATA

NAME: _____
 LOCATION: _____
 OWNER: _____
 OTHER: _____

NUMBER: _____
 DATE: _____
 DRAWING NO: _____
 SPECIFICATION SECTION: _____

Name of equipment checked:

Name of manufacturer of equipment:

1. The equipment furnished by us has been checked on the job by us. We have reviewed, where applicable, the performance verification information submitted to us by the Contractor.
2. The equipment is properly installed, except for items noted below.*
3. The equipment is operating satisfactorily, except for items noted below.*
4. The written operating and maintenance information, where applicable, has been presented to the Contractor, and been discussed with him in detail. Five (5) copies of all applicable operating and maintenance information and parts lists have been furnished to him.

Checked By:

Name of Manufacturer's Rep.

Name of General Contractor

Address and Phone # of Rep.

Authorized Sig./Title/Date

Sig./Title/Pers. Making Chk.

Name of Subcontractor

Date Checked

Authorized Sig./Title/Date

Manufacturer's Representative Notations: Exceptions noted at time of check were:

Manufacturer's Representative to note adequacy of related equipment that directly affects operation, performance or function of equipment checked. (No comment presented herein will indicate adequacy of related systems or equipment):

CERTIFICATE OF COMPLETED DEMONSTRATION FORM

<input type="checkbox"/>	OWNER	<u>City of Kalamazoo</u>	No. Copies	_____	CERTIFICATE OF COMPLETED DEMONSTRATION MEMO NO. _____
<input type="checkbox"/>	ENGINEER:	<u>Tetra Tech</u>	No. Copies	_____	
<input type="checkbox"/>	ARCHITECT:	_____	No. Copies	_____	
<input type="checkbox"/>	CONTRACTOR:	_____	No. Copies	_____	
<input type="checkbox"/>	FIELD:	_____	No. Copies	_____	
<input type="checkbox"/>	OTHER:	_____	No. Copies	_____	

PROJECT DATA

CONTRACT DATA

NAME: _____
LOCATION: _____
OWNER: _____
OTHER: _____

NUMBER: _____
DATE: _____
DRAWING NO: _____
SPECIFICATION
SECTION: _____

NOTE TO CONTRACTOR:

Submit five (5) copies of all information listed below for checking at least one (1) week before scheduled demonstration of the Work. After all information has been approved by the Engineer, give the Owner a Demonstration of Completed Systems as specified and have the Owner sign five (5) copies of this form. After this has been done, a written request for a final inspection of the system shall be made.

MEMORANDUM:

This memo is for the information of all concerned that the Owner has been given a Demonstration of Completed Systems on the work covered under this Specification Section. This conference consisted of the system operation, a tour on which all major items of equipment were explained and demonstrated, and the following items were given to the Owner:

- (a) Owner's copy of Operation and Maintenance Manual for equipment or systems specified under this Section containing approved submittal sheets on all items, including the following:
 - (1) Maintenance information published by manufacturer on equipment items.
 - (2) Printed warranties by manufacturers of equipment items.
 - (3) Performance verification information as recorded by the Contractor.
 - (4) Check-Out Memo on equipment by manufacturer's representative.
 - (5) Written operating instructions on any specialized items.
 - (6) Explanation of guarantees and warranties on the system.
- (b) Prints showing actual "As-Built" conditions.

(c) A demonstration of the system in operation and of the maintenance procedures which will be required.

(Name of General Contractor)

By: _____
(Authorized Signature, Title and Date)

(Name of Subcontractor)

By: _____
(Authorized Signature, Title and Date)

Operation and Maintenance Manuals, Instruction Prints, Demonstration and Instruction in Operation Received:

(Name of Owner)

By: _____
(Authorized Signature/Title/Date)

END OF SECTION

SECTION 01730 - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for cutting and patching.
- B. Related Sections:
 - 1. Refer to other Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work. Requirements of this Section apply to mechanical and electrical installations. Refer to Division 15 and Division 16 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.
 - 2. Demolition of selected portions of the building for alterations is included in Section 02225.

1.02 SUBMITTALS

- A. Cutting and Patching Proposed Method: Where approval of procedures for cutting and patching is required before proceeding, submit a proposal describing procedures well in advance of the time cutting and patching will be performed and request approval from ENGINEER to proceed.

1.03 QUALITY ASSURANCE

- A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio.
- B. Operational and Safety Limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance or decreased operational life or safety.
- C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in ENGINEER's opinion, reduce the building's aesthetic qualities, or result in visual evidence of cutting and patching. Remove and replace Work cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Use materials that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance shall equal or surpass that of existing materials.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Before cutting existing surfaces, examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered.

3.02 PREPARATION

- A. Provide temporary support of Work to be cut.
- B. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.
- C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Take all precautions necessary to avoid cutting existing pipe, conduit, or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them.

3.03 PERFORMANCE

- A. Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
- B. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.
- C. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible review proposed procedures with the original installer; comply with the original installer's recommendations.
 - 1. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.
- D. Comply with requirements of applicable Sections of Division 2 where cutting and patching requires excavating and backfilling.
- E. Cap, valve or plug, and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after bypassing and cutting.
- F. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
 - 1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Patch, repair or rehang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.04 CLEANING

- A. Thoroughly clean areas and spaces where cutting and patching is performed or used as access. Remove completely paint, mortar, oils, putty, and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore damaged pipe covering to its original condition.

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. Refer to the General Conditions for terms of CONTRACTOR's special warranty of workmanship and materials.
- C. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions 2 through 16.
- D. 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. 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.
- B. 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.
- C. 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 final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion, or when OWNER took possession of and responsibility for corresponding elements of the Work.
 5. Submit consent of surety to final payment.
 6. Submit a final liquidated damages settlement statement.
 7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 8. Submit record drawings, maintenance manuals, final Project photographs, damage or settlement survey, property survey, and similar final record information.
 9. Deliver tools, spare parts, extra stock, and similar items.
 10. Make final changeover of permanent locks and transmit keys to OWNER. Advise OWNER's personnel of changeover in security provisions.
 11. Complete start-up testing of systems, and instruction of OWNER's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- 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, 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 REINSPECTION FEES

- A. Should the Engineer perform reinspections due to failure of the Work to comply with the claims of status of completion made by the Contractor:
1. Contractor will compensate the Owner for such additional services.
 2. Owner will deduct the amount of such compensation from the final payment to the Contractor.

1.06 SUBMITTALS

- A. Submit written warranties to ENGINEER prior to the date certified for Substantial Completion. 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. When a designated portion of the Work is completed and occupied or used by OWNER, by separate agreement with CONTRACTOR during the construction period, submit properly executed warranties to ENGINEER within 15 days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by CONTRACTOR, or CONTRACTOR and a subcontractor, supplier, or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to OWNER through ENGINEER for approval prior to final execution.
- D. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.

1.07 RECORD DOCUMENT SUBMITTALS

- A. Record Drawings:
1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown.
 2. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Drawings. The Record Drawings shall be supplemented by any detailed sketches as necessary or directed to indicate, fully, the Work as actually constructed. These master Record Drawings are the Contractor's representation of as-built conditions, including all revisions made necessary by addenda, change orders, RFIs, or other changes, and shall be maintained up-to-date during the progress of the Work.
 3. Mark whichever Drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 4. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the Record Drawings shall be updated indicating any portions which are superseded by change order drawings or final shop drawings including appropriate reference information describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.
 5. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
 6. Mark new information that is important to OWNER, but was not shown on Contract Drawings or Shop Drawings.
 7. Note related Change Order numbers where applicable.
 8. Organize Record Drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates, and other identification on the cover of each set.
- 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 Section 01600, 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.
- 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.
 - 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. Vacuum carpeted surfaces.
 - 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.
- D. 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.
- E. 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

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 of interior partitions marked "remove" on Drawings.
 - 3. Removal of doors and frames marked "remove" on Drawings. Removal of built-in casework marked "remove" on Drawings. Removal of existing windows shown as "bricked-in."
 - 4. Removal and protection of existing fixtures and equipment items shown or marked as "remove and salvage."
 - 5. 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 Supplementary 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.
 - 1. When equipment items are indicated for removal, all ancillary utilities, electrical items, concrete supports, and structural steel supports shall be completely removed unless indicated otherwise.
- B. Remove and Salvage: Items shown as "remove and salvage" remain OWNER's property. Carefully remove and clean salvage items; pack or crate to protect against damage.
- C. 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.
- D. 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. Use of elevator and stairs.
 8. Detailed sequence of selective demolition and removal Work to ensure uninterrupted progress of OWNER's on-Site operations.
 9. Coordination of OWNER's continuing occupancy of portions of existing building and of OWNER's partial occupancy of completed Work.
 10. Locations of temporary partitions and means of egress.
- C. Inventory list of existing equipment to be removed and not reused in Work. OWNER to determine or select items for retention by OWNER.
- D. Qualification Data: For refrigerant recovery technician.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

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.
- B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.
- C. 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. Existing Conditions: OWNER will be continuously occupying building areas immediately adjacent to selective demolition areas.
- D. OWNER assumes no responsibility for actual condition of items or structures scheduled for selective demolition.
- E. OWNER will maintain conditions existing at Contract commencement insofar as practical. However, variations within structure may occur by OWNER's removal and salvage operation before selective demolition Work begins.

- F. Asbestos presence is unknown within buildings to be selectively demolished. If asbestos presence is suspected or confirmed, notify OWNER's Representative prior to disturbing suspected material.
 - 1. Do not disturb asbestos or any material suspected of containing asbestos except under procedures specified in General Conditions.

1.07 SEQUENCING

- A. Conduct selective demolition Work in manner that minimizes need for disruption or interference of OWNER's normal on-Site operations.
 - 1. Existing sodium hexametaphosphate system shall remain operational until new chemical system is tested and approved and coordinated with OWNER.
 - 2. Existing Phosphate Chemical Feed System and tank to be relocated during the installation of the new system. Existing shall not be demolished until the new system is fully functional. All relocations and demolition plans will need to be discussed with the city. Contractor shall schedule a demolition meeting for each station to discuss the phasing plan with the city for their approval prior to demolition.
- B. Coordinate with OWNER's continuing occupation of portions of existing building, with OWNER's partial occupancy of completed new addition and OWNER's reduced usage during summer months.
- 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 minimum of 72 hours advance notice to OWNER of demolition activities which affect OWNER's normal operations.
- D. Give minimum of 72 hours advance notice to OWNER if shutdown of service is necessary during changeover.

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.

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.
 - 1. Existing chemical storage and feed systems shall remain operational until startup of new system. OWNER will feed as much stored liquid phosphate product as possible prior to startup of new system. Remaining liquid sodium hexametaphosphate and liquid poly-orthophosphate product may be landfill disposed. Under no circumstances shall any chemical be disposed to surface waters, sanitary sewer, or wastewater treatment plant.
 - 2. OWNER will remove existing solid sodium hexametaphosphate.
- 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 1 inch 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, driveways, onsite parking, 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 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 accordance with section 02310, 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

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.
 - a. Control of surface and subsurface water, ice, and snow are part of dewatering requirements.
 - b. All costs for dewatering trenches shall be included in prices Bid for other items of Work listed on Bid Form.

1.02 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and construction slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.

1.03 SUBMITTALS

- A. Shop Drawings for Information: Show arrangement, locations, and details of wells and well points; location of headers and discharge lines: and means of discharge and disposal of water.
 - 1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 - 2. Include plan to resist “sanding” or loss of fine soils from around wells, including method of monitoring sanding such as meters made for that purpose or diverting flow into a large barrel to check for sand content.
 - 3. Include documentation of control procedures to adopt if dewatering issues arise.
 - 4. Details for carbon filtration equipment.
 - 5. Include shop drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: Dewatering contractor shall have a minimum of 10 years of work experience involving projects of similar scope and complexity.
- C. Photographs or video, sufficiently detailed, of existing condition of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.
- D. Record drawing at project completion identifying and locating capped utilities and other subsurface structural, electrical or mechanical conditions performed during dewatering.
 - 1. Note location, capacity and depth of wells and well points.

1.04 QUALITY ASSURANCES

- A. Regulatory Requirements; Comply with water disposal requirements of authorities having jurisdiction.

1.05 PROJECT CONDITIONS

- A. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, regularly resurvey benchmarks, maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify engineer if changes to the elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DEWATERING

- A. Protect structures, utilities, sidewalks, pavement and other facility from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening or damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the City Engineer and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- D. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- E. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- F. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- G. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction. Pumping systems shall not impede vehicular access on the site.
 - H. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to the City.
 1. Remove dewatering system from project site on completion of dewatering. Well abandonment shall be in accordance with Part 127, Act 368, PA 1978 and all State of Michigan requirements.
 - I. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

SECTION 02310 - EARTH MOVING

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. Excavating and filling for rough grading the Site.
 - 2. Preparing subgrades for walks, pavements, turf and grasses and plants.
 - 3. Excavating and backfilling for buildings and structures.
 - 4. Drainage course for concrete slabs-on-grade.
 - 5. Subbase course for concrete walks and pavements.
 - 6. Subbase course and base course for asphalt paving.
 - 7. Subsurface drainage backfill for walls and trenches.
 - 8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.03 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.

- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D1586.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Project site.
 - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Personnel and equipment needed to make progress and avoid delays.
 - b. Coordination of Work with utility locator service.
 - c. Extent of trenching by hand or with air spade.
 - d. Field quality control.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
 - 2. Warning tapes.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D2487.
 - 2. Laboratory compaction curve according to ASTM D1557.
- C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.07 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.08 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 02230 "Site Clearing" are in place.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
- D. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- E. Granular Fill:
 - 1. Densely Graded: MDOT Specifications, Section 902, No. 21AA, 21A or 22A.
 - 2. Open Graded: ASTM C33, coarse aggregate, No. 57. MDOT Specifications, Section 902, 6A.
- F. Base Course for Pavement: MDOT Specifications, Section 902; 21AA, 21A or 22A, as indicated on the drawings.
- G. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

- I. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- J. Drainage Course: Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.
- K. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.
- L. Sand: MDOT Specifications, Section 902; granular materials meeting the gradation limits of Class II.
- M. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Drainage Geotextile: For use as a soil separator. Nonwoven needle punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent meeting the requirements below:
 - 1. Apparent opening size: No. 70 to 100 sieve, maximum ASTM D4751.
 - 2. Minimum Grab Tensile Strength: 200 lb.; ASTM D4632.
 - 3. Minimum Weight: 6 oz./sq. yd.
- B. Erosion Control Geotextile: For use on side slopes to prevent surface erosion. Biodegradable Erosion Control Blanket (ECB) manufactured to provide erosion control and vegetation establishment. Includes manufacturer's anchoring system.
 - 1. Woven lightweight jute or coconut fiber material.
 - 2. Square matrix with 45-65 percent open area.
 - 3. 100% Biodegradable.
 - 4. Longevity: 1 to 2 years.
 - 5. Product must be recommended for seeding and planting both before and after ECB installation.
- C. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability: Class 2; AASHTO M 288.
 - 2. Survivability: As follows:
 - a. Grab Tensile Strength: 247 lbf; ASTM D4632.
 - b. Sewn Seam Strength: 222 lbf; ASTM D4632.
 - c. Tear Strength: 90 lbf; ASTM D4533.
 - d. Puncture Strength: 90 lbf; ASTM D4833.
 - 3. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
 - 4. Permittivity: 0.02 per second, minimum; ASTM D4491.
 - 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.03 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.03 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

- B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation. Changes in the Contract Time may be authorized for rock excavation.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.
 - a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
 - 2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.04 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.05 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.

3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.06 SUBGRADE INSPECTION

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.07 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi, may be used when approved by Engineer.
 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.08 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.09 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.

6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

E. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil 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.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:
 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 96 percent.
 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 96 percent.
 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
 4. For utility trenches, compact each layer of initial and final backfill soil material at 96 percent.

3.14 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.15 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.

- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.
 - 2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 - 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place base course material over subbase course under hot-mix asphalt pavement.
 - 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
 - 4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
 - 5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.17 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 - 1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place drainage course 6 inches or less in compacted thickness in a single layer.
 - 3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.18 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.

2. Determine that fill material classification and maximum lift thickness comply with requirements.
 3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
 - C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
 - D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
 - E. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2,000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.
 - F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

- B. All soil leaving site shall be disposed in a landfill. Contractor shall arrange for any testing needed for acceptance by landfill.

END OF SECTION

SECTION 02630 - SEWERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for furnishing the fabrication, production, installation, or erection of the items specified in this Section as shown on Drawings or listed on Schedule.
- B. Excavation, trenching, and complete and continual dewatering of excavation; sheeting, bracing, or shoring of sides of excavation; furnishing and installing of the pipe and bedding; backfilling; placing, and maintaining temporary roadway surfaces over trenches in streets, drives, and parking areas; testing; and disposal of excess excavated materials are to be done under Division 2 Sections of the Specifications.

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. Design details of the joint before ordering any pipe.
 - 2. Boring and jacking methods of construction prior to performing any boring and jacking operation.
 - 3. Pressure grout design mix.
- B. Quality Control Submittals: All pipe delivered to Site shall be accompanied by certification papers showing that the pipe has been tested in accordance with applicable Specifications and that the pipe meets these Specifications.
- C. Test and Inspection Report: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01600.
 - 1. The requirements for the necessary Infiltration/Exfiltration Tests are found in detail under "Laying Pipe" Article.
- D. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 SEWER PIPE

- A. Locations of various types of pipe are shown on Drawings. Sanitary sewer pipe shall be designed for air testing.
- B. Sewer pipe and fittings used in this Work shall meet requirements of referenced standard specifications. Sewer piping shall be of following types as noted on Drawings:
 - 1. Polyvinyl Chloride Gravity Pipe (PVC): ASTM D 3034 or ASTM D F 679, SDR 35.

2. Perforated Corrugated PVC Pipe (PCPP): ASTM F 949. Pipe with stiffness at 5 percent deflection of 46 psi. Perforation shall conform to requirements of ASTM F 949.

2.03 PIPE JOINTS

A. Polyvinyl Chloride Pipe:

1. Joints in polyvinyl chloride pipe shall be bell and spigot type unless solvent weld joints are specified. Bell and spigot joints shall consist of spigot and formed bell complete with a factory installed flexible elastomeric gasket meeting ASTM F 477.
2. Joints for pressure pipe (PVCP) shall conform to ASTM D 3139. Joints for non pressure pipe (PVC) shall conform to ASTM D 3212. Solvent weld joints shall conform to ASTM D 2855.
1. Joints in tee branches, wyes, fittings, riser pipes, and service laterals shall be similar to (including pressure rating) and compatible with joints furnished for sewer pipe. Joints shall be made using lubricant as recommended by pipe manufacturer. When necessary to field cut standard length of pipe, the new spigot end shall be prepared as recommended by pipe manufacturer.

PART 3 - EXECUTION

3.01 DISPOSAL OF WATER AND SEWAGE

- A. CONTRACTOR shall remove by well points, pumping, bailing, or other acceptable method any water which may accumulate or be found in the trenches or other excavations to be made. CONTRACTOR shall make all necessary provisions to keep the trenches and other excavations entirely free of water during construction of pipelines and structures. Newly laid concrete shall be adequately protected from injury resulting from groundwater or sewage or from the handling or disposal of water or sewage. No drainage ditches shall be placed within the area to be occupied by any structure except as permitted by ENGINEER.
- B. CONTRACTOR shall always have upon the Site sufficient pumping equipment ready for immediate use to carry out the intent of this Section. All cost for dewatering trenches shall be incidental to the Contract.
- C. Additional requirements for dewatering are specified in Section 02240.

3.02 LAYING PIPE

- A. Pipe shall be laid from downstream to upstream, starting at the most downstream end of a run, unless approved by ENGINEER.
- B. Lay pipe with bells upgrade and to line and grade called for on Drawings. Finished sewer shall be straight and free of dirt or debris.
- C. Inspect each pipe for defects prior to being lowered into trench. Clean inside of pipe and outside of tongue and grooves of dirt or foreign matter. Place joint materials as recommended by manufacturer.
- D. Center pipe in grooves and push tight together to form smooth and continuous invert. Use mechanical means for pulling pipe home in making up joint and for holding pipe joints tight until completion of line. Mechanical means shall consist of a cable placed inside of pipe with a suitable winch, jack, or come-along for pulling pipe home and holding pipe in position.

- E. Use laser-aligning equipment for laying of sewers to specified lines and grades. Furnish equipment and personnel required to operate laser equipment.
 - 1. Rigidly mount laser beam projection to its support platforms in a manner approved by ENGINEER. This will ensure that ground equipment vibrations will be kept to minimum and will permit laser beam to be projected coaxially through center of pipe. Furnish units with equipment to control atmospheric conditions in pipe which could affect construction.
- F. ENGINEER will establish centerline stakes and offset stakes at each manhole and other centerline and offset stake as required for check points.
- G. Provide openings in pipe, as required for installation of laser equipment, at no additional cost to OWNER. Details of these openings will be approved by ENGINEER.
- H. After pipe is laid, carefully compact bedding under the haunches of pipe, and backfill trench to 12 inches above pipe. Place sufficient backfill after each joint is made along sides of pipe to offset conditions that might tend to move pipe off line and grade. Relay pipe found off grade or out of line.
- I. Allowable Tolerances in Sewer Grade: Construct and lay sewers to alignment and grade shown on Drawings or designated by ENGINEER. A variation greater than 1/4 inch from plan or designated grade is sufficient reason for rejection of sewer; and sewer shall be re-laid to proper grade if so directed by ENGINEER, at no cost to OWNER.

3.03 CONNECTIONS TO EXISTING SEWERS

- A. When service lateral sewer or other pipe is to be connected to existing sewer, use an, Inserta Tee, or approved tapping saddle. Wyes shall be of the same material as pipe unless otherwise approved by ENGINEER, and shall be as set forth under "Wye Branch Connections" Article. Direct taps of rigid pipes, other than cored taps, shall not be permitted unless approved in writing by ENGINEER.
- B. When a new section of sewer or wye is to be installed in-line with an existing sewer, use compression-type coupling with shear rings. Adjustable rings are required in couplings 6 inches or larger. Clamps and shear ring shall be stainless steel.

3.04 FIELD QUALITY CONTROL

- A. General:
 - 1. Conduct acceptance tests for tightness on sanitary sewers. In areas where live leads must be connected as Work progresses, only television inspection shall be required.
 - 2. Test sewers 24 inches in diameter and smaller using low-pressure air. Also test sewers for infiltration where groundwater is above sewer invert. In areas where groundwater is more than 2 feet above the sewer crown at upstream end, air test with dewatering system in operation or use infiltration test after dewatering system is turned off and groundwater has returned to its normal level.
 - 3. Test all sewers using infiltration or exfiltration tests as directed by ENGINEER.
 - 4. Make provisions for determining groundwater level prior to testing. ENGINEER shall be able to confirm level by visual inspection. Water level holes in manholes shall be sealed watertight after sewer has passed test.
 - 5. CONTRACTOR may, at CONTRACTOR'S option, test any or all the sewer lines prior to backfilling. However, such tests shall be in addition to required test following backfilling of trench.

6. Following completion of first section of sewer, if ENGINEER determines that there is some question as to installation of sewer, ENGINEER may direct CONTRACTOR to conduct a presumptive test to check installation for defective pipe or faulty joints before it is completely covered with backfill material.
 7. Provide necessary materials, equipment, and personnel to conduct tests.
 8. Acceptance test sections include entire length of sewer under Contract.
 9. Clean and flush pipe prior to conducting acceptance tests.
 10. Make tests under supervision of ENGINEER. Submit testing schedule and procedures for CONTRACTOR and approval by ENGINEER prior to start of Work.
- B. Repair visible leakage in sewers or manholes even though acceptance tests have been satisfactory.
- C. Project Acceptance:
1. Acceptance of sanitary sewer system is contingent upon but not limited to satisfactory completion of all work including materials tests, service lead records, and Record Drawings. A review of the grade and alignment will be completed by the ENGINEER based on the Record Drawings. Sewer grades and the drops between inlets and outlets will be checked against the design grades and elevations.

LOW PRESSURE AIR TEST TABLES
 TIME REQUIRED FOR 1.0 PSIG PRESSURE DROP
 WHEN TESTING ONE PIPE DIAMETER ONLY FOR SIZE AND LENGTH OF PIPE INDICATED.

TABLE FOR PVC, PVCP, ABS AND DI PIPE

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft.)	4 Time for Longer Length (sec.)	Test Time for Length (L) Shown (min:sec)							
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

TABLE FOR VCP AND CONCRETE PIPE

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft.)	4 Time for Longer Length (sec.)	Test Time for Length (L) Shown (min:sec)							
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	1:53	597	0.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:48	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
36	17:00	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	19:50	57	20.939L	34:54	52:21	69:48	87:15	104:42	122:09	139:36	157:03

Note: When testing two sizes of pipe simultaneously, time shall be computed by ratio of lengths involved.

Example: 400 feet of 8-inch PVC pipe and 150 feet of 6-inch VCP pipe.

$$\text{Time} = \frac{\text{Time} = \text{Length}_1 \times \text{Time}_1 + \text{Length}_2 \times \text{Time}_2}{\text{Length}_1 + \text{Length}_2}$$

$$= \frac{400 \times 10:08 + 150 \times 2:50}{400 + 150} = \frac{400 \times 608 + 150 \times 170}{400 + 150} = 489 \text{ seconds} = 8:09 \text{ (min:sec).}$$

END OF SECTION

SECTION 02740 - HOT MIX ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of hot mix asphalt (HMA) paving Work is shown on Drawings.

1.02 REFERENCES

- A. MDOT Standard Specifications for Construction, 2020 Edition:
 - 1. 302 Aggregate Base Course.
 - 2. 306 Aggregate Surface Course.
 - 3. 501 Plant-Produced Hot Mix Asphalt.
 - 4. 902 Aggregates.
- B. ASTM:
 - 1. D 5581: Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6-inch Diameter Specimen).

1.03 DESIGN REQUIREMENTS

- A. HMA pavement shall be as detailed on the Drawings or matching existing thickness, whichever is greater.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.
- B. Quality Assurance Submittals:
 - 1. Provide copies of materials certificates, signed by material producer and CONTRACTOR, certifying that each material item complies with or exceeds specified requirements.
 - 2. Provide a laboratory-designed, Superpave mix design for all HMA mixtures. The mix design shall include, at a minimum, the asphalt content, compacted mixture specific gravity theoretical maximum specific gravity, air voids, voids filled with asphalt (VFA), voids mineral aggregate (VMA), mix proportions, stability, flow, aggregate gradation, crush content, and job mix formula.

1.05 QUALITY ASSURANCE

- A. Codes and Standards: Comply with MDOT Standard Specifications for Construction, 2020 Edition.

1.06 SITE CONDITIONS

- A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50 degrees F (10 degrees C), and when temperature has not been below 35 degrees F (1 degree C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
 - 1. Construct asphalt concrete surface course when atmospheric temperature is above 40 degrees F (4 degrees C), and when base is dry. HMA base course over 2 inches thick may be placed when air temperature is above 35 degrees F (-1 degree C) and rising. HMA may not be placed between November 15 and May 5.
- B. Establish and maintain required lines and elevations. Grade control shall be according to MDOT standards.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Use locally available materials and gradations which meet the specifications requirements and exhibit a satisfactory record of previous installations.
 - 1. Base Course Aggregate: MDOT Specification 21AA, 21A, or 22A.
 - 2. Surface Course Aggregate: MDOT Specification 22A.
 - 3. Mineral Filler: MDOT Specification 3MF.
 - 4. Asphalt Cement: Asphalt penetration (viscosity) rate of 120 to 150.
 - 5. Bond Coat: MDOT Specification SS-1h or CSS-1h.
 - 6. Lane Marking Paint: Chlorinated rubber-alkyd type, AASHTO M 248 (FS TT-P-115), Type III.
- B. Pavement Markings
 - 1. Waterborne pavement markings shall be in accordance with MDOT Section 811. Color: White

2.02 ASPHALT-AGGREGATE MIXTURE

- A. HMA mixture shall be MDOT 4EML furnished and placed in accordance with MDOT Specifications 501.
- B. When tested at the optimum asphalt content in accordance with ASTM D 5581, the bituminous mixture shall meet the requirements for stability, 1,100 pounds, flow, 8-16 hundredths of an inch, air voids 3.0 percent, and voids in mineral aggregate, 13.5 percent.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

- A. Proof roll prepared subbase surface to check for unstable areas and areas requiring additional compaction. Do not begin base construction or paving Work until deficient subbase areas have been corrected and are ready to receive paving.
- B. Pavement along edges of existing HMA surfaces shall be removed as directed by ENGINEER to construct butt joints.

- C. Tack Coat: Apply to contact surfaces of previously constructed HMA or Portland cement concrete and surfaces abutting or projecting into HMA pavement. Distribute at rate of 0.10 gallon per square yard of surface. Apply to all edges of concrete curb and gutter.
 - 1. Allow to cure until at proper condition to receive paving.
- D. Exercise care in applying HMA materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

3.02 PLACING MIX

- A. Place HMA mixture on prepared surface, spread and strike-off in accordance with MDOT Specifications. Spread mixture at minimum temperature of 225 degrees F (107 degrees C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness as shown on Drawings.
- B. Paver Placing: Place in strips to line up with lane lines in accordance with MDOT Specifications.
- C. Joints: Make joints between old and new pavements or between successive days' work, to ensure continuous bond between adjoining Work. Construct joints to have same texture, density, and smoothness as other sections of HMA course. Clean contact surfaces and apply tack coat. All joints on new pavement shall be vertical joints. Joints on old to new pavement shall be butt joints.

3.03 ROLLING

- A. Begin rolling when mixture will bear roller weight without excessive displacement.
 - 1. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.
- C. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
- D. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.
- E. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cutout such areas and fill with fresh, HMA. Compact by rolling to maximum surface density and smoothness.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
 - 1. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.04 FIELD QUALITY CONTROL

- A. In-place HMA courses will be tested for compliance with requirements for thickness and surface smoothness by OWNER. CONTRACTOR shall repair or remove and replace unacceptable paving as directed by ENGINEER.
 - 1. In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness:
 - a. Base Course: 1/4 inch, plus or minus.
 - b. Surface Course: 1/4 inch, plus or minus.
 - 2. Surface Smoothness: Test finished surface of each HMA course for smoothness, using 10-foot straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness.
 - 3. Base Course Surface:
 - a. Lower Courses: 3/4 inch.
 - b. Top Course: 3/8 inch.
 - 4. Leveling and Wearing Course Surface:
 - a. Multiple Course Construction:
 - 1) 1/8 inch for top course.
 - 2) 1/4 inch for lower course.
 - b. Single Course Construction: 1/4 inch.

END OF SECTION

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 the pipe 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 Conditions and Division 1, apply to Work of this Section.

1.02 REFERENCES

- A. MDOT Standard Specifications for Construction, 2020 Edition:
 - 1. 302 Aggregate Base Course.
 - 2. 306 Aggregate Surface Course.
 - 3. 501 Plant Mixed Hot Mix Asphalt.
 - 4. 902 Aggregates

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 SITE CONDITIONS

- A. Weather Conditions: Construct asphalt concrete surface course when atmospheric temperature is above 40 degrees F (4 degrees C), and when base is dry. Bituminous base course over 2 inches thick may be placed when air temperature is above 35 degrees F (-1 degree C) and rising. Asphalt may not be placed between November 15 and May 5.

1.06 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 BITUMINOUS PAVEMENT

- A. Bituminous pavement shall be as specified in section 02740.

2.04 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.

2.05 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.

2.06 TREE/SHRUB REPLACEMENT

- A. Stakes and Wrap: Trees shall be staked and wrapped. Stakes for guying shall be wood, 2-inch by 2-inch by 30 inches long, minimum size.
- B. Stakes for staking shall be sound, 4-inch-diameter, 9-foot-long cedar posts with bark skinned off for shade trees; 2-inch by 2-inch by 8 feet long for conifers under 5 feet in height.
- C. Staking wire shall be No. 12-gauge galvanized steel.

- D. Hose for covering wire shall be new or used, black or red, 2-ply, fiber-reinforced garden hose, not less than 1/2-inch inside diameter. Seconds rejected by factory are acceptable.
- E. Tree wrap shall be treated wrapping Kraft wrap or approved equal.
- F. Plant Materials:
 - 1. Quality and Size: Plant materials shall be sound, healthy, vigorous, and free from plant diseases and insect pests or their eggs and shall have normal, healthy root systems. All measurements such as spread, ball size, number of canes, quality designation, etc., shall be in accordance with the latest edition of AAN USA Standard for nursery stock. Trees shall be calipered 6 inches above the ground.
 - 2. Sources: Must be located in the same or higher hardiness zone as determined by the latest edition of the "Plant Hardiness Zone Map," Agricultural Research Service, U.S. Department of Agriculture.
 - 3. Plant Material Quality Assurance, Plant Material Selection and Approval Operations: All trees required by this Contract shall be tagged by CONTRACTOR at the source for inspection and approval by ENGINEER in writing at least 2 weeks prior to each desired inspection date. Photographs of materials may be required for preliminary inspection of materials from remote sources.
 - 4. Root Protection: Trees and shrubs shall be balled and burlapped. They shall be dug with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root systems necessary for full recovery of the plant. Balls shall be securely wrapped with burlap and bound with cord. No balled and burlapped plant shall be planted if the ball is cracked or broken.
 - 5. Protection During and After Delivery: All plant material is to be delivered to Site in closed vehicles or in open vehicles with the entire load properly covered in transit for protection from drying winds. They shall be planted immediately upon delivery. No plant shall be bound with rope or wire in a manner that would damage the bark or break the branches.

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 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 SAW CUT JOINTS

- A. Damaged areas shall be removed by sawing a straight-cut parallel with longitudinal and transverse construction or contraction joints. No saw cuts shall be nearer than 5 feet to a longitudinal or transverse joint or to the edge of the pavement. If the damaged area is less than 5 feet from an existing joint, the existing surface shall be saw-cut 5 feet from the damaged area, removed, and

replaced. If the damaged area is less than 5 feet from the edge of the pavement, the removal and replacement shall be extended to said edge of pavement.

- B. Saw cutting of concrete shall be done with a carborundum saw to a minimum depth of half the slab thickness or that depth required to cut reinforcing steel. Bituminous surfaces shall be cut full depth.
- C. After the trench is backfilled and before the pavement over the trench is replaced, all angular and ragged irregularities on the edges of the cut pavement shall be removed giving a smooth and regular edge of pavement. Payment for cut joints required shall be included under the unit price of pavement restoration.

3.03 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.

3.04 AGGREGATE BASE

- A. Place aggregate base on a prepared subbase or subgrade in accordance with construction methods described in Section 302 of MDOT Specifications.

3.05 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.

3.06 CONCRETE CONSTRUCTION

- A. Pavement: The surface of concrete pavements shall be properly consolidated and struck off to such elevations to match adjacent pavement and made uniform by transverse floating. As soon as all excess moisture has disappeared, the pavement shall be given a final light brooming finish by dragging a seamless strip of damp burlap or cotton fabric. Edges of all joints shall be tooled.
 - 1. 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.

3.07 SEEDING

- A. Wherever the pipe 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 screened, 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.

3.08 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.

3.09 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 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of items specified in this Section as shown on Drawings or listed on Schedules.
- 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.
- C. Products Installed but not Furnished under this Section:
 - 1. Anchor bolts.
 - 2. Miscellaneous metal embedments.

1.02 DEFINITIONS

- A. Flowable Fill: Cement Stabilized Fly Ash Fill (CSFAF) consisting of cement, fly ash, and water. These Specifications classify this material as Class F mix.

1.03 REFERENCES

- A. ASTM:
 - 1. A 185 Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.
 - 2. A 497 Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
 - 3. A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 4. C 31 Test Methods of Making and Curing Concrete Test Specimens in the Field.
 - 5. C 33 Concrete Aggregates.
 - 6. C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 7. C 42 Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 8. C 94 Ready-Mixed Concrete.
 - 9. C 143 Test Method for Slump of Hydraulic Cement Concrete.
 - 10. C 150 Portland Cement.
 - 11. C 157 Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
 - 12. C 171 Sheet Materials for Curing Concrete.
 - 13. C 172 Practice for Sampling Freshly Mixed Concrete.
 - 14. C 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 15. C 231 Test Method for Air Content of Freshly Mixed Concrete by Pressure Method.
 - 16. C 260 Air-Entraining Admixtures for Concrete.
 - 17. C 309 Liquid Membrane-Forming Curing Compounds for Curing Concrete.
 - 18. C 494 Chemical Admixtures for Concrete.
 - 19. C 578 Preformed, Cellular Polystyrene Thermal Insulation.
 - 20. C 595 Blended Hydraulic Cements.
 - 21. C 618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
 - 22. C 845 Expansive Hydraulic Cement.
 - 23. C 881 Epoxy-Resin-Base Bonding Systems for Concrete.
 - 24. C 989 Ground Iron Blast-Furnace Slag for Use in Concrete and Mortars.

25. C 1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
26. C 1240 Silica Fume for Use as a Mineral Admixture in Hydraulic Cement Concrete.
27. D 994 Preformed Expansion Joint Filler for Concrete (Bituminous Type).
28. D 471 Test Method for Rubber Property – Effect of Liquids.
29. D 1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextending and Resilient Bituminous Types).
30. D 1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
31. D 3963 Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars.
32. E 1155 Test Method for Determining Floor Flatness and Levelness Using the F-Number System (Inch-Pound Units).
33. E 1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
34. E 1745 Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

B. MDOT: Standard Specifications for Construction.

C. ACI:

1. 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
2. 222.1 Provisional Standard Test Method for Water-Soluble Chloride Available for Corrosion of Embedded Steel in Mortar and Concrete Using the Soxhlet Extractor.
3. 301 Specification for Structural Concrete.
4. 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete.
5. 305R Hot Weather Concreting.
6. 306R Cold Weather Concreting.
7. 309R Guide for Consolidation of Concrete.
8. 318R Building Code Requirements for Structural Concrete and Commentary.
9. 347R Guide to Formwork for Concrete.
10. 350R Environmental Engineering Concrete Structures and Commentary.
11. 503R Use of Epoxy Compounds with Concrete.
12. SP-66 ACI Detailing Manual.

D. CRSI:

1. Manual of Standard Practice.
2. Placing Reinforcing Bars.

1.04 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.

1. Shop Drawings of Reinforcement: Submit original shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with Reinforcement Shop Drawing Checklist below.
 - a. Reinforcement Shop Drawing Checklist:
 - 1) Specify ASTM number and grade of reinforcing.
 - 2) Show bar spacings and quantities.
 - 3) Specify lap lengths using table in Tetra Tech, Inc. Structural Standard Details.
 - 4) Specify whether bars are inside and outside or near face and far face on walls.

- 5) Specify clear coverages per Placing Reinforcement Specification in Part 3.
 - 6) Specify bar support spacings per Tetra Tech, Inc. Standard Detail for Concrete Slabs.
 - 7) Show stirrup spacing.
 - 8) Use closed stirrups and ties with 135-degree hooks.
 - 9) Submit Bar Bending Schedule on Drawings.
 - 10) Reference major Contract Drawings. Use same section cut numbers and letters when practical.
 - 11) Show details for additional reinforcing items. Examples are reinforcing around openings, control joints, equipment pads, masonry reinforcement.
 - 12) Show numeric elevation references on sections.
 - 13) Locate expansion and control joints.
 - 14) Organize and present sheets in logical sequence.
 - 15) Submit "small" submittal packages when practical.
 - 16) Immediately contact ENGINEER if Contract Documents are unclear.
- B. Product Data: Submit data for proprietary materials and items, including admixtures, patching compounds, waterstops, joint systems, curing compounds, and other materials installed under this Section.
- C. Submit samples of materials as requested by ENGINEER, including names, sources, and descriptions.
- D. Mix Designs: Submit the following for all concrete classes:
1. Water/cement ratio (total gallons of water per cubic yard).
 2. Brand, type, and quantity of cement.
 3. Type and quantity of aggregates.
 4. Type and quantity of admixtures.
 5. Type, composition, and quantity of fly ash, slag (GGBFS), or silica fume.
 6. Unit weight (wet density).
 7. Composition strength based on 28-day compression test.
- E. Submit laboratory test reports for concrete mix design, aggregates (particularly deleterious materials in coarse aggregate) and fly ash, slag (GGBFS) and silica fume (if used) 4 weeks before scheduled pouring.
- F. Quality Assurance Submittals:
1. Submit written reports to ENGINEER documenting testing and inspection results. Prepare report as noted in Section 01450.
 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.

1.05 PROJECT CONDITIONS

- A. Protection of Footings against Freezing: Cover completed Work at footing level with sufficient temporary or permanent cover to protect footings and adjacent subgrade against possibility of freezing. Maintain cover for curing period or until temperatures cannot affect concrete footings.
- B. Protect adjacent finish materials against spatter during concrete placement.

1.06 OWNER'S INSTRUCTIONS

- A. Concrete Testing Service: Engage testing laboratories acceptable to ENGINEER to do material evaluation tests and to design concrete mixes.
- B. Materials and installed Work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at CONTRACTOR's expense.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

- A. Forms for Smooth Form Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel materials, to achieve continuous, straight, smooth, exposed surfaces. Furnish largest practicable sizes to minimize joints and to conform to joint system shown on Drawings.
- B. Forms for Rough Form Finish Concrete: Plywood, lumber, metal, or other acceptable material. Use lumber dressed on two edges and one side for tight fit.
- C. Form Coatings: Commercial formulation form-coating compounds with no more than 350 mg/ltr volatile organic compounds (VOCs) that do not bond with, stain, or adversely affect concrete surfaces, or prevent good bonding with later concrete surface treatments.
- D. Forms Ties: Factory fabricated, adjustable length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units which shall leave no metal closer than 1-1/2 inches to surface.
 - 1. Provide ties which, when removed, leave holes no larger than 7/8-inch or less than 1/2-inch in diameter in concrete surface.

2.02 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Welded Wire Fabric: ASTM A 185.
- C. Welded Deformed Steel Wire Fabric: ASTM A 497.
- D. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar supports complying with CRSI specifications. The use of bricks is not permitted.
 - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material does not support chair legs.
 - 2. For exposed-to-view concrete surfaces, where support legs are in contact with forms, use supports with legs that are plastic-protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.03 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I, except use Type III where applications require high-early-strength.
- B. Blended Cement: Type II.
- C. Use one brand of cement throughout Project, unless otherwise acceptable to ENGINEER.
- D. Fly Ash: ASTM C 618, Type C with loss on ignition not more than 6 percent.
- E. Ground Granulated Blast-Furnace Slag: ASTM C 989.
- F. Silica Fume: ASTM C 1240.
- G. Aggregates: ASTM C 33. Use aggregates from single source for exposed concrete.
 - 1. Fine aggregate: MDOT 2NS.
 - 2. Coarse aggregate: MDOT 6AA or 26A.
- H. Water: Potable.
- I. Air-Entraining Admixture: ASTM C 260 and certified by manufacturer to be compatible with other admixtures.
- J. Water-Reducing Admixture: ASTM C 494, Type A.
- K. High-range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or Type G.
- L. Water Reducing, Nonchloride Accelerator Admixture: ASTM C 494, Type E.
- M. Water Reducing, Retarding Admixture: ASTM C 494, Type D.
- N. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions.

2.04 ACCESSORIES

- A. Granular Base: Evenly graded fine aggregate to provide smooth and even surface below slabs on grade. Minimum 6-inch thickness or as noted on Drawings.
- B. Nonshrink Grout: ASTM C 1107, factory pre-mixed, cementitious natural aggregate grout.
- C. Moisture-Retaining Cover: Waterproof paper, polyethylene film, or polyethylene-coated burlap complying with ASTM C 171.
- D. Transparent Membrane-Forming Curing Compound: Liquid membrane-forming curing compound complying with ASTM C 309, Type 1, Class B. Formed membrane shall be suitable for later application of cementitious coating or topping.
- E. Mechanical Anchors: Manufactured using corrosion-resistant materials.

- F. Adhesive Anchoring System: ASTM C 881, Type IV, Grade 3. Provide material Class to suit Project requirements.

2.05 PROPORTIONING AND DESIGN OF MIXES

- 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 and silica fume 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 MDOT 6AA, except for Class G concrete which shall use MDOT 26A.
- 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 (footings, slabs, walls, columns, beams, equipment bases, and slab toppings 2 inches or greater in thickness).
 - b. Class S Sulfate resistant structural concrete (footings, 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		4,500	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		0.42	0.40	0.44	0.44	0.58	0.75	0.40-0.75
Air Content, percent by volume		6±1.5	<4	5±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

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

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 crystalline concrete admixture where noted on design drawings.

2.06 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with ASTM C 94 requirements and as specified in this Section.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Coordinate installation of joint materials, perimeter insulation, and vapor retarders with placement of forms and reinforcing steel.

3.02 FORMS

- A. Design, build, support, brace, and maintain formwork to support vertical and lateral, static, and dynamic loads applied to formwork until concrete structure can support applied loads. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position. Deflection of form-facing material between supports, and deflection of form supports shall not exceed 1/4 inch per 10 feet of span.
- B. Design formwork to be removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades level and plumb for work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features in Work. Use selected materials to obtain specified finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, and recesses to prevent swelling and for easy removal.
- E. Provide temporary openings at base of wall and column forms and other interior areas of formwork where it is inaccessible for cleanout, for observation before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Chamfer exposed corners and edges, 3/4 inch minimum, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing these items. Accurately place and securely support items built into forms.
- H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing after concrete placement to eliminate mortar leaks and to maintain proper alignment.

3.03 PLACING REINFORCEMENT

- A. Comply with CRSI recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports, and as specified in this Section.
 - 1. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers.

- D. Place reinforcement to obtain clear cover space for concrete protection:
 - 1. Footings and slabs cast over mud mats, supported slabs, beams, girders, columns, and walls, both interior and exterior unless noted otherwise: 2 inches.
 - 2. Footings and slabs cast against and permanently exposed to earth: 3 inches.
- E. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Direct wire tie ends into concrete, not toward exposed concrete surfaces.
- 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.
- G. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces one full mesh and lace splices with wire.

3.04 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.

3.05 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.

3.06 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. Cold Weather Placing: Protect concrete work from physical damage or reduced strength attributed to frost, freezing actions, or low temperatures by using techniques in ACI 306R and as specified in this Section.
 - 1. When air temperature has fallen to, or is to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain concrete mixture temperature not less than 50 degrees F, and not more than 80 degrees F at placement point.
 - 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 and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

- J. Hot Weather Placing: When air temperature is above 85 degrees F, conditions could exist that would seriously impair quality and concrete strength; place concrete in compliance with ACI 305R and as specified in this Section.
 - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 85 degrees F. Chill mixing water or use chopped ice to control temperature. If using ice, water equivalent of ice is included in total mixing water quantity. Using liquid nitrogen to cool concrete is CONTRACTOR's option.
 - 2. Cover reinforcing steel with water-soaked burlap, if steel becomes too hot, to reduce steel temperature so not to exceed ambient air temperature immediately before embedment in concrete.
 - 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete.
 - 4. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.07 FINISH OF FORMED SURFACES

- A. Rough Form Finish: Use for formed concrete surfaces not exposed to view in finish Work during normal operation or maintenance, or by other construction and not covered with coating or covering material applied directly to concrete. This concrete surface has texture imparted by form-facing material. Tie holes and defective areas are repaired and patched, and fins and other projections exceeding 1/4-inch in height are rubbed down or chipped off.

- B. Smooth Form Finish: Use for formed concrete surfaces exposed-to-view, during normal operation or maintenance, or are covered with coating or covering material applied directly to concrete, including waterproofing, dampproofing, painting, or other similar system. This is as-cast concrete surface obtained with selected form material, arranged orderly and symmetrically with minimum seams. Repair and patch defective areas. Remove and smooth fins or other projections completely. Fill major air void holes.

- C. Grout Cleaned Finish: Provide grout-cleaned finish to scheduled formed concrete surfaces that are painted, stained, or waterproofed after receiving smooth form finish treatment.
 - 1. Combine 1 part Portland cement to 1-1/2 parts fine sand by volume, and mix with water to consistency of thick paint. Proprietary additives may be used at CONTRACTOR's option. Blend standard Portland cement and white Portland cement, quantities determined by trial patches, so that dry grout color matches adjacent surfaces.
 - 2. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for 36 hours after rubbing.

- D. Related Unformed Surfaces: At horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with texture matching adjacent formed surfaces. Continue surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless shown otherwise.

3.08 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise shown.
 - 1. After placing slabs, plane surface to tolerances for floor flatness (FF) of 15 and floor levelness (FL) of 13 in accordance with ASTM E 1155.
 - 2. Slope surfaces uniformly to drains. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified, and slab surfaces which are covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise shown.
 - 1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit power-driven float operation. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units.
 - 2. Check and level surface plane to tolerances of floor flatness (FF) of 18 and floor levelness (FL) of 15 in accordance with ASTM E 1155.
 - 3. Cut down high spots and fill low spots.
 - 4. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to uniform, smooth, granular texture.
- C. 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.
- D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
- E. Non-slip 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.

3.09 CONCRETE CURING AND PROTECTION

- 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.
 2. High-early-strength concrete: 3 days.
- C. Curing Methods: Cure concrete for water-retaining structures by moist curing. Cure concrete for other structures by curing compound, moist curing, moisture-retaining cover curing, or combinations thereof.
- 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. Provide Curing Compound as follows:
 1. Apply specified curing compound to concrete slabs as soon as last finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain coating continuity and repair damage during curing period.
 2. Transparent curing compound shall be used for structural concrete (Class A concrete). White curing compound shall be used for exterior pavements (Class P concrete) and sidewalks (Class B concrete).
 3. Do not use membrane curing compounds on surfaces that are covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (ceramic or quarry tile, glue-down carpet), painting, and other coatings and finish materials, unless otherwise acceptable to ENGINEER.
- G. 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.
- H. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

3.10 SHORES AND SUPPORTS

- A. Comply with ACI 347R for shoring and reshoring in multi-story construction and as specified in this Section.
- B. Extend shoring from ground to roof for structures four stories or fewer unless otherwise permitted.
- C. Extend shoring three floors under floor or roof placements for structures over 4 stories. Shore floor directly under floor or roof placements, so loads from construction transfer directly to these shores.

Space shoring in stories below this level so no floor or member is excessively loaded or has induced tensile stress in concrete members where no reinforcing steel is present. Extend shores beyond minimums to ensure proper load distribution throughout structure.

- D. Remove shores and reshore in planned sequences to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.
- E. Keep reshores in place 15 days after placing upper tier, or until concrete has attained its 28-day strength, or until heavy construction loads are removed.

3.11 FORM REMOVAL

- 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 footings and beams (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.

3.12 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in Work. Split, frayed, delaminated, or damaged form-facing materials are not acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.
- B. When extending forms for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces.

3.13 MISCELLANEOUS CONCRETE ITEMS

- A. Fill-in holes and openings left in concrete structures for work by other trades, unless otherwise shown or directed. Do fill in after other trades' work is in place. Mix, place, and cure concrete to blend with in-place construction. Provide other miscellaneous concrete filling shown to complete Work.
- B. Removal of Existing Concrete: Remove existing concrete where shown or required. Neatly finish concrete edges remaining in place and exposed to view in finished structure with cement mortar.
 - 1. Concrete cutting shall be done competently without injury to remaining portions of structures.
- C. Bonding New to Old Concrete: Where shown on Drawings, existing concrete surfaces against which new concrete is placed shall be thoroughly cleaned and brush-coated with bonding agent. Follow manufacturer's directions, especially on material working time.
- D. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with approved Shop Drawings from manufacturer-furnishing machines and equipment.
 - 1. Grout baseplates and foundations using specified and approved nonshrink grout.

3.14 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after form removal.
 - 1. Cut out honeycomb, rock pockets, voids over 1/4-inch in dimension, and holes left by tie rods and bolts, down to solid concrete but no less than 1 inch deep. Make cuts perpendicular to concrete surface. Thoroughly clean, dampen with water, and brush-coat patched area with specified bonding agent. Place patching mortar after bonding compound has set as recommended by manufacturer.
 - 2. For exposed to view surfaces, blend white Portland cement and standard Portland cement so, when dry, patching mortar matches surrounding color. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repair of Formed Surfaces: Remove and install new concrete having defective surfaces if defects are irreparable to satisfaction of ENGINEER. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins, and other projections on surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.
 - 1. Repair concealed formed surfaces, where practical, containing defects which affect concrete durability. If defects are irreparable, remove and install new concrete.
- C. Repair of Unformed Surfaces: Test unformed surfaces for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as specified in this Section. Test unformed surfaces sloped to drain for slope trueness using templates having required slope.
 - 1. Repair finished unformed surfaces containing defects which affect concrete durability. Defects include crazing, cracks more than 0.01-inch wide or which penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
 - 2. Correct high areas in unformed surfaces by grinding, after concrete has cured 14 days.

3. Correct low areas in unformed surfaces during or immediately after surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to ENGINEER.
 4. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with 3/4-inch clearance around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete to provide same concrete type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- D. Repair isolated random cracks and single holes not over 1-inch in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete. Clean out dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of 1 part Portland cement to 2-1/2 parts fine aggregate passing No. 16 mesh sieve, using only enough water as specified for handling and placing. Place dry-pack after bonding compound has set per manufacturer's instructions. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
- E. Structural Repairs: Do structural repairs with prior approval by ENGINEER for method and procedure using specified epoxy adhesive and mortar.
- F. Repair Methods: ENGINEER may allow use of other nonspecified methods subject to review and acceptance by ENGINEER.

3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. The Contractor will retain, at its own expense, a Testing Laboratory to conduct concrete testing and inspections and to submit test and inspection reports for all concrete work. The Contractor's Testing Laboratory will be responsible for inspections and for directing and interpreting all required tests.
- B. 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: ASTM C 39, one set for each day's pour exceeding 5 cubic yards plus additional set for each 100 cubic yards over and above first 50 cubic yards of each concrete class placed in 1 day; 1 specimen tested at 7 days, 2 specimens tested at 28 days, and 1 specimen retained in reserve for later testing if required.
- C. 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.

- D. 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.
- E. 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.
- F. At locations where concrete quality is deemed questionable by ENGINEER, core-boring tests shall also be made at CONTRACTOR's expense.
- G. 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.
- H. 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.
- I. 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 03930 - REPAIR OF EXISTING CONCRETE STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of repair of existing concrete structures shown on Drawings and specified, and includes patching loose, spalled, and unsound concrete, grouting cracks, removing debris resulting from Work, and other Work required to produce a neat and complete job.
- B. Related Documents: Drawings and general provisions of Contract, including General Conditions and Division 1, apply to Work of this Section.

1.02 METHODS OF PAYMENT

- A. Repair over 2 inches Deep: Measure surface area and average depth after surface preparation and prior to beginning actual repair. ENGINEER, with CONTRACTOR, will determine the volume of each location for repair. These measurements shall be done to the nearest inch, and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown, will be included in a Change Order increasing or decreasing the Contract Price noted on Bid Form.
- B. Repair Equal to or Less than 2 Inches Deep: Work shall be paid for by the square foot of surface area repaired. Measure surface area after surface preparation and prior to beginning actual repair. ENGINEER, with CONTRACTOR, will determine the surface area of each location or fraction of each location for repair that is equal to or less than 2 inches deep. These measurements shall be done to the nearest 0.1 square foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown shall be included in a Change Order increasing or decreasing the Lump Sum Bid Price noted on Bid Form.
- C. Pressure Injection of Epoxy Resin: Work will be paid for by the linear foot of crack injected. These measurements shall be done to the nearest linear foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown shall be included in a Change Order increasing or decreasing the Lump Sum Bid Price noted on Bid Form.
- D. Pressure Injection of Hydrophilic Grout: Work will be paid for by the linear foot of crack injected. These measurements shall be done to the nearest linear foot and then totaled for comparison with the quantity shown on Drawings. The difference in quantities over or under those shown shall be included in a Change Order increasing or decreasing the Lump Sum Bid Price noted on Bid Form.

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 for proprietary materials and items, including patching compounds and others requested by ENGINEER.
 - 2. Samples of materials as requested by ENGINEER, including names, sources, and descriptions.

- B. Material 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.
- C. Qualification Data for Installers.
 - 1. Manufacturer's certificates that the installer's workers are trained and qualified for each type of product.
 - 2. Satisfactory experience record including references from previous applications of the specified materials for repairs of a similar type and under similar conditions.
- D. Repair Plan: Submit before Work begins.
- E. Store tightly sealed materials off ground and away from moisture, direct sunlight, extreme heat, or freezing temperatures.

1.04 FIELD CONDITIONS

- A. Cold-Weather Requirements for Cementitious Materials: Do not apply unless concrete-surface and air temperatures are above 40-degrees F and will remain so for at least 48 hours after completion of Work.
- B. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures 90-degrees F and above.
- C. Protect adjacent finish materials against spatter during patching operations.

PART 2 - PRODUCTS

2.01 PATCHING MATERIALS

- A. Patching up to 2-inch Deep: Cement-polymer patching mortar with an integral corrosion inhibitor suitable for the particular patching application.
- B. Patching over 2-inches Deep: Class A concrete with the use of an epoxy bonding agent applied at the bonding surfaces, unless otherwise noted.
- C. Epoxy Bonding Agent: Epoxy-modified cementitious material with integral corrosion inhibitor.
- D. Epoxy Gel Adhesive: Moisture-tolerant 2-component epoxy adhesive conforming to ASTM Specification C 881.
- E. Epoxy Injection Resin: Moisture-insensitive 2-component epoxy-resin system conforming to ASTM Specification C 881, Type I. Provide Grade and Class to suit Project requirements.
- F. Grouting of Non-structural and Leaking Cracks: Moisture reactive (hydrophilic) TDI (toluene diisocyanate) based polyurethane chemical grout. For structures in contact with potable water, chemical grout shall be NSF 61 approved.

2.02 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

PART 3 - EXECUTION

3.01 GENERAL

- A. All workers shall have sufficient experience on concrete repair work to be familiar with the use of these materials and methods of operation.
- B. To ensure the quality of the finished work, ENGINEER may require CONTRACTOR to replace workers who, in ENGINEER's judgment, are not capable or qualified to perform this Work. CONTRACTOR, upon receipt of the written notification from ENGINEER, shall immediately comply with this request at no additional cost to OWNER.

3.02 PREPARATION

- A. Ensure that supervisory personnel are on-site and on duty when concrete repair work begins and during its progress.

3.03 PATCHING

- A. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries.
- B. Square cut perimeter of areas to be patched to a minimum depth of 1/4-inch. Remove deteriorated or unsound concrete as required to reach sound concrete. Removal shall be to a minimum depth of 1/4-inch.
- C. Thoroughly clean by sandblasting all corroded and rusted reinforcement. Wherever a reinforcing bar has lost more than 30 percent of its cross-sectional area, place a new bar of the same size parallel to it using 24-bar diameters lapped length at each end. When a bar has exposed 50 percent or more of its perimeter, chip out the concrete around the bar to provide a minimum of 1-inch gap all around so the bar can be completely encased in new mortar.
- D. Test areas where concrete has been removed by tapping with a hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
- E. After concrete removal, mechanically prepare concrete surface to obtain a minimum surface profile of 1/16-inch +/-.
- F. Thoroughly clean dirt, oil, dust, or foreign matter from repair surfaces. Dampen concrete substrate to a saturated surface dry condition. Coat substrate with bonding agent.
- G. The patching material must be applied within the working time of the bonding agent. Use bonding agent only on surfaces not requiring formwork or when the patching material can be applied within manufacturer's recommended working time.

- H. Prepare the cement mortar per manufacturer's recommendations. Apply mortar with a spatula pressed tight against existing surfaces and filling all voids. Build up mortar to original lines in one or more layers, with each layer thickness not to exceed that recommended by the manufacturer, and finished smooth with a steel trowel.

3.04 PRESSURE INJECTION OF CRACKS

- A. Drilling Injection Holes:
 - 1. Pressure injection of epoxy resin: Drill holes into face of crack.
 - 2. Pressure injection of hydrophilic grout: Drill injection holes along the sides of the cracks set at an angle of 45-degrees from the surface of the concrete so the holes intersect the crack near the mid-section of the concrete. Alternate holes from one side of crack to the other.
 - 3. Minimum hole spacing should equal thickness of the concrete to be repaired.
- B. Flush drilling dust out of out of injection holes by use of water and a flushing wand that reaches the back of the hole. Install injection packers or ports in the injection holes. Mechanically clean and surface seal cracks wider than 1/8-inch with hydraulic cement or epoxy gel adhesive.
- C. Thoroughly flush cracks with potable water prior to grout injection.
- D. Inject chemical grout, maintaining slow, steady pressure until crack is filled. In slabs, injection shall start at the first packer or port that was flushed with water. In walls, injection shall start at the lowest packer or port. Move to next adjacent packer or port when the injection material appears from adjacent packers or ports. Reinject first packer or port after pumping a number of locations.
- E. Remove injection packers or ports and patch injection holes with patching mortar. Remove excess cured grout, hydraulic cement, or epoxy gel and clean surface.

3.05 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcing placement and supports.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond to patching material.
- C. Accurately position, support, and secure reinforcement against displacement by construction or patching operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers.
- D. Place reinforcement to obtain minimum coverings for reinforcement protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during patching operations. Set wire ties to direct ends into concrete, not toward exposed surfaces.

3.06 SURFACE FINISHES

- A. Patching: Provide finish to match adjacent concrete surfaces unless otherwise noted.

3.07 CURING AND PROTECTION

- A. Protect freshly placed material from premature drying and excessive cold or hot temperatures.
- B. Patching up to 2 Inches Deep: Perform curing as recommended by patching mortar manufacturer.
- C. Patching over 2 Inches Deep: Perform curing of Class A concrete.

3.08 REPAIR OF DEFECTS

- A. Repair patch areas that lack uniformity or have honeycomb, rock pockets, voids over 1/4-inch in diameter, and holes left by tie rods and bolts.

END OF SECTION

SECTION 04200 - UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Concrete unit masonry.
 - 2. Clay unit masonry in the form of brick.
 - 3. Dimension stone masonry trim in unit masonry walls.

1.02 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following installed compressive strengths (f_m):
 - 1. For concrete unit masonry:
 - a. $f_m = 2000$ pounds per square inch (minimum).
 - 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. Mason Qualifications: The masonry foreman responsible for the placement of reinforced masonry must submit a copy of the certificate that they have successfully completed the Masonry Institute of Michigan (MIM) training program for reinforced unit masonry assemblies.
- C. 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. Brick data required consists of the following:
 - a. Brick Grade.
 - b. Brick Type.
 - c. Material Test Data:
 - 1) Minimum compressive strength.
 - 2) Maximum water absorption.
 - 3) Maximum saturation coefficient (C/B ratio).
 - 4) Initial rate of absorption (IRA).
 - 5) Efflorescence.
 - 6) Chippage limitations.
 - d. Material Certification of Compliance.
 - 2. 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.
 3. 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.
 4. 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.
 5. Joint reinforcement, ties, anchors, and flashing:
 - a. Manufacturer's literature.
 - b. Material Certificate of Compliance.
- D. 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.
- E. 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.
 2. Colored masonry mortar samples showing full extent of colors available.
- F. Samples for verification purposes of the following:
1. Full-size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction.
 - a. Include size variation data verifying that actual range of sizes for brick falls within ASTM C 216 dimension tolerances for brick where modular dimensioning is indicated.
 2. Colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.
- G. 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.
- 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. A qualified Engineer or Architect must inspect masonry during construction for compliance with the Contract Documents, including conducting the pre-installation conference, inspection of the field-constructed mock-ups, and periodic wall inspection of the critical portions of masonry construction, including flashing, weep hole construction, and proper unit bedding and joint installation techniques for structural integrity and weather-tightness.
 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.

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. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. FBX Standard Clay Face Brick:
 - a. Belden Brick Company
 - b. Brick type 1 "Commodore Velour", Brick Type 2 "Seal Brown Velour".
 - c. General Shale, Inc.
 2. Water-Repellent Admixture:
 - a. Dry Block Water-Repellent Block Admixture by W.R. Grace and Co.
 - b. Rheomix Rheopel by Master Builders, Inc.
 3. Integral Water-Repellent Admixture:
 - a. Dry-Block Mortar Admixture by W.R. Grace and Co.
 4. Joint Reinforcement:
 - a. Dur-O-Wal, Inc.
 - b. Heckman Building Products, Inc.
 - c. Hohmann and Barnard, Inc.
 - d. Masonry Reinforcing Corp. of America.

5. Ties and Anchors:
 - a. Dur-O-Wal, Inc.
 - b. Heckman Building Products, Inc.
 - c. Hohmann and Barnard, Inc.
 - d. Masonry Reinforcing Corp. of America.
6. Metal Flashing:
 - a. "Cheney Flashing (Dovetail)," Cheney Flashing Company, Inc.
 - b. "Cheney Flashing (Sawtooth)," Cheney Flashing Company, Inc.
 - c. "Keystone Three-Way Interlocking Thruwall Flashing," Keystone Flashing Co.
7. Copper Fabric Laminate Flashing:
 - a. "Copper Fabric," Afco Products, Inc.
 - b. "Type FCC-Fabric Covered Copper," Phoenix Building Products.
 - c. "Copper Fabric Flashing," Sandell Manufacturing Co., Inc.
 - d. "York Copper Fabric Flashing," York Manufacturing, Inc.
8. Single-wythe Flashing Unit System:
 - a. "Blok-Flash," Sandell Manufacturing Company, Inc.
9. Mortar Net:
 - a. Hohmann and Barnard, Inc.
10. Louvered Vinyl Brick Vents/Weep Holes:
 - a. Wire-Bond No. 3602, Masonry Reinforcing Corp. of America.
 - b. "Williams-Goodco Brick Vents," Williams Products, Inc.
 - c. No. 343 Louvered Weep Hole, Hohmann & Barnard, Inc.
11. Plastic Rectangular Weep Hole:
 - a. No. 342 Plastic Weep Hole, Hohmann and Barnard.
 - b. Wire-Bond No. 3603 Clear Rectangular Vent, Masonry Reinforcing Corp. of America.
12. Extruded Polystyrene Board Insulation:
 - a. "Styrofoam Scoreboard," Dow Chemical USA.
 - b. "Foamular 250," Owens Corning.
 - c. "CertiFoam 25 SE," DiversiFoam Products
 - d. "Green Guard SB," Pactiv Corporation.
13. Loose Granular Vermiculite Insulation:
 - a. "Zonolite Masonry Insulation," Grace Construction Products.

2.02 MATERIALS

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

2.03 CLAY MASONRY UNITS

- A. Comply with the following requirements applicable to each form of brick required:
 1. Provide special molded shapes where indicated and as follows:
 - a. For applications requiring brick of form, color, texture, and size on exposed surfaces that cannot be produced by sawing standard brick sizes.
 2. Provide units without cores or frogs and with all exposed surfaces finished for ends of sills, caps, and similar applications that expose brick surfaces that otherwise would be concealed from view.

B. Face Brick Standard: ASTM C 216 and as follows:

1. Grade and Unit Compressive Strength: Provide units of grade and minimum average net area compressive strength indicated below:

<u>Grade: SW</u>	<u>Average of Five Bricks</u>	<u>Individual Brick</u>
Compressive Strength pounds per square inch, gross area	3,000	2,500
Max. Water Absorption by 5-hour boiling, percent	17.0	20.0
Max. Saturation Coefficient (C/B ratio)	0.78	0.80

2. ASTM C 216-89 with the following exceptions:

- a. Durability:

- 1) Waiver Brick shall only be accepted at the discretion of ENGINEER. The brick must have been used locally and displayed a satisfactory proven record of durability for a minimum of 5 years.

- b. Initial Rate of Absorption (IRA):

- 1) Brick shall comply with the following IRA values as per ASTM C 67:

- General Use: - Maximum of 20 grams per minute.
 - Minimum of 5 grams per minute.
Cold Weather Use: - Maximum of 15 grams per minute.
 - Minimum of 7 grams per minute.

- c. Materials and Finish:

- 1) Coring and Frogging: If cored brick units are used, they shall have 3 circular cores not to exceed 1-1/2 inches in diameter. Any panel frogs shall not exceed 3/8 inch in depth. No deep frog units shall be used.

3. Not less than the unit compressive strengths required to produce clay masonry construction of compressive strength indicated.
4. Type FBX: For general use in exposed masonry requiring minimum variations in size and color ranges.
5. Size: Provide bricks manufactured to the following actual dimensions within the tolerances specified in ASTM C 216:
 - a. Standard: 3-5/8 inches thick by 2-1/4 inches high by 8 inches long.
6. Shape units during manufacture as indicated below:
 - a. Molding.
 - b. Pressing.
 - c. Extruding.
 - d. Any method indicated above.
7. Application: Use where brick is exposed, unless otherwise indicated.
8. Wherever shown to "match existing," provide face brick of matching color, texture, and size as existing adjacent brickwork.
9. Color and Texture: Match ENGINEER's sample.

2.04 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. 2000 pounds per square inch.
 - 2. Weight Classification:
 - a. Normal weight (greater than 125 pounds per cubic foot concrete).

2.05 MORTAR AND GROUT MATERIALS

- A. Mortar and Grout
 - 1. Mortar Compressive Strength (Type S): 1,900 pounds per square inch (minimum).
 - 2. Grout Compressive Strength: 2,500 pounds per square inch (minimum).
- 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.
- 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. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars.
- I. Water: Clean and potable.

2.06 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:
 - 1. Billet steel complying with ASTM A 615, Grade 60.
- C. Deformed Reinforcing Wire: ASTM A 496.
- D. Plain Welded Wire Fabric: ASTM A 185.

2.07 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.
 - 4. For multi-wythe masonry provide type as follows:
 - a. Adjustable (two-piece) type; ladder design with perpendicular cross rods spaced not more than 16 inches on center with one side rod for each face shell of backing wythe with separate ties that extend into facing wythe. Ties have 2 hooks that engage eyes in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have clips to engage a continuous horizontal wire in the facing wythe
 - 1) Number of Side Rods for Multi-wythe Concrete Masonry: One side rod for each face shell of hollow masonry units more than 4 inches in nominal width, plus one side rod for each wythe of masonry 4 inches or less in nominal width.

2.08 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.

2.09 BENT WIRE TIES

- A. Individual units pre-fabricated from bent wire to comply with requirements indicated below:
- B. Type for Masonry where Coursing Between Wythes Align: Unit ties bent from one piece of wire.

2.10 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.

2.11 MISCELLANEOUS ANCHORS

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

2.12 EMBEDDED FLASHING MATERIALS

- A. Exposed Sheet Metal Flashing: Fabricate from the following metal, complying with requirements specified in Section 07600 and below.
 - 1. Stainless Steel: 0.0156 inch (28 gauge) thick.
 - 2. Fabricate through-wall metal flashings embedded in masonry as follows:
 - a. With ribs formed in dovetail pattern at 3-inch intervals along length of flashing to provide a 3-way integral mortar bond and weep hole drainage.
 - 3. Fabricate metal expansion joint strips from sheet metal indicated above, formed to shape indicated.
 - 4. Application: Use where flashing is exposed to exterior and is partly concealed in masonry wall.

2.13 MISCELLANEOUS MASONRY ACCESSORIES

- A. Nonmetallic Expansion Joint Strips: Pre-molded filler strips complying with ASTM D 1056, Type 2 (closed cell), Class A (cellular rubber and rubber-like materials with specific resistance to petroleum base oils), Grade 1 (compression-deflection range of 2-5 pounds per square inch), compressible up to 35 percent, of width and thickness indicated, formulated from the following material:
 - 1. Neoprene.

- B. Mortar Net: Provide mortar net made of high-density polyethylene (HDPE) or nylon stands woven into a 90 percent open-mesh, formed into dovetail shape to break up mortar droppings and prevent mortar damming. Mortar net shall be nonreactive with common building materials, nonabsorbent, shall not support mold or fungus growth, and shall be inedible to insects.
- C. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Louvered Vinyl Brick Vents/Weep Holes: PVC injection molded vent, 1-1/2-inch high by 3/4-inch wide with 3-3/8-inch by 1-1/4-inch top flap. Weeps shall be formed by installing injection-molded flexible PVC louver weeps configured to direct water out of cavity and preventing inward flow while allowing air passage and pressure equalization. Louvered weeps shall include compressible flanges to accommodate joint width and rectangular closure strip to prevent mortar droppings from clogging openings.
- E. Plastic Rectangular Weep Hole: Clear Butyrate 3/8-inch wide by 1-1/2-inch high by 3-1/2-inch deep tube.
- F. Weep Holes: Field-fabricated. See Part 3, Execution, Flashing/Weep Holes for requirements.
 - 1. Weeps shall be formed by omitting lower 1/2 of head joint mortar and pouring granular fill, to fill weep and cavity to top of first brick course as recommended by MIM.

2.14 INSULATION

- A. Extruded Polystyrene Board Insulation: Rigid cellular polystyrene thermal insulation with closed cells and integral high-density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578, Type IV (25 pounds per square inch compressive strength); in manufacturer's standard lengths and widths; thicknesses as indicated.
 - 1. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.15 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.

2.16 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, Property Specification for job-mixed mortar.
 - 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.
 - 3. For reinforced masonry use type indicated below unless otherwise indicated on Drawings:
 - a. Type S.
 - 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.
- C. Colored Aggregate Mortar: Produce mortar of color required by use of colored aggregates in combination with selected cementitious materials.
 - 1. Mix to match ENGINEER's sample.
- D. Grout for Unit Masonry: Comply with ASTM C 476 and referenced unit masonry standard.

2.17 SOURCE QUALITY CONTROL

- A. Brick Tests: For each type and grade of brick indicated, units will be tested by qualified independent testing laboratory per ASTM C 67, except 5 bricks will be selected at random for each 100,000 units or fraction thereof installed.
- B. 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. Wetting Clay Brick: Not Permitted.
- D. Do Not Wet concrete masonry units.
- E. 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.
- F. When vertical reinforcement is called for, mortar face shell and web of cores containing grout and reinforcing bars.

- G. 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.
- H. 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.
- I. 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.
- J. 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 solid brick-size masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
- B. No Furrowing Allowed: Mortar shall be spread and beveled into a battered pyramid formation. Peak of formation shall be at a position approximately 2/3 the distance from back of brick to the exterior face as recommended by MIM.
- C. Head Joints of Brick shall be mortared full and slightly battered at face and back edges.
- D. Installation Technique Recommended by MIM: Position brick into mortar from the back side approximately 1 inch behind previously laid brick, behind the line. Roll brick forward and down to the line, shoving into bond position. This procedure is recommended to control mortar flow to extrude excess mortar at the exterior face of brick; also impose compression of the head joint to assure fullness and tightness. Any mortar fins that may protrude into the cavity area shall be parged against the back of the brick at this time. Comply with MIM recommendations.
- E. Lay hollow concrete masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
- F. 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.
- G. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

3.06 STRUCTURAL BONDING OF MULTI-WYTHE MASONRY

- A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes.

- B. Corners: Provide interlocking masonry unit bond in each course at corners unless otherwise shown.
 - 1. Provide continuity with horizontal joint reinforcement at corners using pre-fabricated L-units in addition to masonry bonding.
- C. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
 - 1. Provide individual metal ties.
 - 2. Provide continuity with horizontal joint reinforcement using prefabricated T-units.
- D. Nonbearing Interior Partitions: Build full height of story to underside of solid floor or roof structure above and as follows:
 - 1. Install pressure-relieving joint filler in joint between top of partition and underside of structure above.

3.07 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.

3.08 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.

3.09 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. For single-wythe walls, space reinforcement at 16 inches on center vertically unless otherwise indicated.
 - 3. For parapets, space reinforcement at 8 inches on center vertically unless otherwise indicated.
 - 4. 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.
 - 5. Cut or interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
 - 6. 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.

3.10 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. Form expansion joints in brick made from clay or shale as follows:
 - 1. Build flanges of factory-fabricated expansion joint units into masonry.
- D. 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.
 - 1. Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.11 LINTELS

- A. Install steel lintels above all masonry brick openings; size of steel lintel shall be per Lintel Schedule on Drawings.
 - 1. Provide 4-inch bearing for all openings less than 4 feet. For openings greater than 4 feet, provide 1 inch of bearing for each foot of span.
 - 2. Steel lintels shall be used at brick veneer locations only. All steel for these lintels shall be hot-dipped galvanized.
- B. Provide masonry lintels where shown and wherever openings of more than 8 inches for brick size units and 1 foot for block size units are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Cure pre-cast lintels before handling and installation. Temporarily support formed-in-place lintels.
 - 1. For hollow concrete masonry unit walls, use specially formed bond beam units with reinforcement bars placed as indicated and filled with coarse grout.
 - 2. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.12 FLASHING/WEEP HOLES/BRICK VENTS

- 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. Install flashing in masonry veneer walls as specified above but carry flashing up face of sheathing at least 8 inches and behind air infiltration barrier/building paper.
 4. Interlock end joints of ribbed sheet metal flashings by overlapping ribs not less than 1-1/2 inches, or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements of Section 07900 for application indicated.
 5. Turn down sheet metal flashings at exterior face of masonry to form drip.
 6. Cut off concealed flashing flush with face of wall after masonry wall construction is completed.
- D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashings and as follows:
1. Form weep holes by keeping one head joint free and clear of mortar as recommended by MIM.
 2. Space weep holes 24 inches on center.
 3. Form weep holes by providing partially open head joints approximately 2 inches high.
 4. Space weep holes 32 inches on center.
 5. In all block core spaces, place peastone to a height not less than 2 inches immediately above flashing embedded in the wall as masonry construction progresses to splatter mortar droppings and to maintain drainage.
 6. In all cavities/air spaces, place mortar net to a minimum height equal to height of first course but not less than 2 inches immediately above flashing embedded in the wall as masonry construction progresses to splatter mortar droppings and to maintain drainage.
 7. Install low vinyl brick vents/weep holes in vertical mortar block joints directly above through-wall flashings. Clip off top flap prior to installation.
 8. Install high vinyl brick vents in vertical mortar joints. Align with weep holes below. See Drawings for typical height location.
 - a. Space brick vents at same spacing as weep holes. Align with weep holes below.
- E. Install reglets and nailers for flashing and other related construction where shown to be built into masonry.

3.13 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.

3.14 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.
 1. Grout compressive strength shall be sampled and tested per ASTM C 1019.
- 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. 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.

3.15 PARGING

- A. Parge pre-dampened masonry walls where indicated with Type S mortar applied in 2 uniform coats to a total thickness of 3/4 inch. Scarify first parging coat to ensure full bond to subsequent coat.
- B. Use a steel trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.
- C. Damp cure parging for at least 24 hours and protect until cured.

3.16 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 brick by means of bucket and brush hand-cleaning method described in BIA, "Technical Note No. 20 Revised," using the following masonry cleaner:
 - a. Job-mixed detergent solution.
 - b. Proprietary acidic cleaner; apply in compliance with directions of acidic cleaner manufacturer.
 6. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 8-2A applicable to type of stain present on exposed surfaces.
 7. Clean limestone units to comply with recommendations in "ILI Handbook" of Indiana Limestone Institute of America, Inc.
- 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

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Steel framing and supports for overhead doors
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 3. Shelf angles.
 - 4. Metal ladders.
 - 5. Structural-steel door frames.
 - 6. Metal bollards.
 - 7. Loose bearing and leveling plates for applications where they are not specified in other Sections.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Loose steel lintels.
 - 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
- C. Related Requirements:
 - 1. Section 04200 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

1.03 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.04 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Fasteners.
 - 2. Shop primers.
 - 3. Shrinkage-resisting grout.
 - 4. Metal bollards.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Steel framing and supports for overhead doors

2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 3. Shelf angles.
 4. Metal ladders.
 - 5.
 6. Structural-steel door frames.
 7. Metal bollards.
 8. Loose steel lintels.
- C. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.
- B. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Research Reports: For post-installed anchors.

1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.01 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 316L.
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 316L.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.02 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- D. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- E. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- F. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 11 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.03 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.04 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.05 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with primer specified in Section 099600 "High-Performance Coatings" where indicated.

2.06 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
 - 1. Provide mitered and welded units at corners.
 - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize shelf angles located in exterior walls.
- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.07 METAL LADDERS

- A. General:
 - 1. Comply with ANSI A14.3.
 - 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
- B. Steel Ladders:
 - 1. Space siderails 16 inches apart unless otherwise indicated.
 - 2. Siderails: Continuous, 3/8-by-4-inch steel flat bars, with eased edges.
 - 3. Rungs: 1-inch- diameter, steel bars.
 - 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 - 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
 - 6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
 - 7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
 - 8. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
 - 9. Primeladders, including brackets and fasteners, with primer specified in Section 099600 "High-Performance Coatings."

2.08 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
 - 1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
- B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
- C. Galvanize and prime exterior steel frames.

D. Prime exterior steel frames with primer specified in Section 099600 "High-Performance Coatings."

2.09 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize and prime exterior miscellaneous steel trim.
- D. Prime exterior miscellaneous steel trim with primer specified in Section 099600 "High-Performance Coatings."

2.10 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe 1/4-inch wall-thickness rectangular steel tubing.
- B. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe with 1/4-inch-thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.
- C. Prime steel bollards with primer specified in Section 099600 "High-Performance Coatings."

2.11 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.
- C. Prime plates with primer specified in Section 099600 "High-Performance Coatings."

2.12 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with primer specified in Section 099600 "High-Performance Coatings."

2.13 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.
- C. Anchor shelf angles securely to existing construction with expansion anchors.
- D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

3.03 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.
- B. Anchor bollards in concrete in formed or core-drilled holes not less than 42 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.
- C. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.04 INSTALLATION OF BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.05 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply brush or spray to provide a minimum 2.0-mil dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09900 "Painting".

- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

SECTION 05521 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Aluminum railings.

1.03 COORDINATION

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Fasteners.
 - 3. Post-installed anchors.
 - 4. Handrail brackets.
 - 5. Bituminous paint.
 - 6. Nonshrink, nonmetallic grout.
 - 7. Anchoring cement.
 - 8. Metal finishes.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For delegated-design professional engineer.
- B. Welding certificates.
- C. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- D. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.08 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 - 1. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.03 ALUMINUM RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

- C. Extruded Tubing: ASTM B221, Alloy 6063-T5/T52.
- D. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.
 - 1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
- E. Drawn Seamless Tubing: ASTM B210/B210M, Alloy 6063-T832.
- F. Plate and Sheet: ASTM B209, Alloy 6061-T6.
- G. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.
- H. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.04 FASTENERS

- A. Fastener Materials:
 - 1. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
 - 2. Aluminum Railing Components: Type 316 stainless steel fasteners.
 - 3. Finish exposed fasteners to match appearance, including color and texture, of railings.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
 - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.05 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Cast iron or Cast aluminum, center of handrail 2-1/2 inches from face of railing or wall.
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
 - 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- D. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.06 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 - 1. Provide weep holes where water may accumulate.
 - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded or nonwelded connections unless otherwise indicated.
 - 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 flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay
- H. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- J. Form changes in direction as follows:
 - 1. As detailed.
 - 2. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

- K. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
- O. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
 - 1. Provide socket covers designed and fabricated to resist being dislodged.
 - 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- P. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.07 ALUMINUM FINISHES

- A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Mill Finish: AA-M12, nonspecular as fabricated.
- C. Clear Anodic Finish: AAMA 611, AA-M12C22A31.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.02 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches of post.

3.03 ANCHORING POSTS

- A. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.

3.04 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with flanges connected to railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends, using nonwelded connections.
- C. Attach handrails to walls with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.

3.05 CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.06 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 06641 – PLASTIC GUARD POST SHIELDS

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:
- B. Plastic guard post covers.
- C. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for guard posts.

1.03 COORDINATION

- A. Coordinate sizes of plastic guard post covers with steel guard post diameters and lengths.

1.04 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Plastic guard post covers.

1.05 FIELD CONDITIONS

- A. Field Measurements: Verify size and projection above grade of all guard posts receiving covers.

PART 2 - PRODUCTS

2.01 PLASTIC GUARD POST COVERS

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Bollard Cover by Ideal Shield.
- B. Plastic guard post covers to comply with the following requirements:
 - 1. Style: Smooth surface, dome top.
 - 2. Construction: Single-piece.
 - 3. Material: Polyethylene thermoplastic (HDPE).
 - 4. Nominal thickness: 0.250-inch.
 - 5. Diameter: Coordinate with steel guard posts.
 - 6. Height: Field verify to coordinate with steel guard posts.
 - 7. Color: Yellow.

2.02 MISCELLANEOUS MATERIALS

- A. Neoprene adhesive or foam tape: As recommended by manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting and fitting required for installing plastic guard post covers.
- B. Install per manufacturer's recommendations using neoprene adhesive tape or foam tape.
- C. Do not install damaged or broken covers.

END OF SECTION

SECTION 07920 - JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Urethane joint sealants.
- B. Related Requirements:

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Joint-sealants.
 - 2. Joint sealant backing materials.
- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.03 INFORMATIONAL SUBMITTALS

- A. Test and Evaluation Reports:
 - 1. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
 - a. Joint-sealant location and designation.
 - b. Manufacturer and product name.
 - c. Type of substrate material.
 - d. Proposed test.
 - e. Number of samples required.
- B. Sample warranties.

1.04 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Authorized representative who is trained and approved by manufacturer.
2. Testing Agency: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.06 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.07 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

- #### A. Obtain joint sealants from single manufacturer.

2.02 JOINT SEALANTS, GENERAL

- #### A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

- #### B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.03 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
- B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
- C. Silicone, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability. nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 35, Use NT.
- D. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
- E. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT.
- F. Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
- G. Silicone, S, NS, 50, T, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Uses T and NT.
- H. Silicone, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.
- I. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.
- J. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
- K. Silicone, M, P, 100/50, T, NT: Multicomponent, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type M, Grade P, Class 100/50, Uses T and NT.

2.04 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

- B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
- C. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.
- D. Urethane, S, P, 35, T, NT: Single-component, pourable, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 35, Uses T and NT.
- E. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
- F. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Use NT.
- G. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Use NT.
- H. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.
- I. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.
- J. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.
- K. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T and NT.

2.05 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) [Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.06 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.

- b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that 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.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
- 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
- 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.04 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

SECTION 08220 - FIBERGLASS REINFORCED PLASTIC (FRP) DOORS AND FRAMES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Section includes fiberglass reinforced plastic (FRP) doors and frames.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM) Specifications.
1. A 123 Zinc Coatings.
 2. C 591-01 Unfaced Preformed Rigid Cellular Polyisocyanurate.
 3. C 728-97 Insulation Board, Mineral Aggregate.
 4. E 330-97 Structural Load Test.
 5. E 1996 Wind Load Test.
 6. E 1886 Impact Test Procedures (inclusive of Large Missile Impact).
- C. Door and Frame Preparation for Hardware, American National Standard Institute Specifications (ANSI).
- D. Recommended Locations for Builder's Hardware, Door and Hardware Institute (DHI).

1.03 PERFORMANCE REQUIREMENTS

- A. Exterior FRP doors shall be designed to meet wind-loading requirements of the Michigan Building Code (MBC). Refer to Structural Drawings for wind and design pressures.

1.04 SUBMITTALS

- A. Submit in accordance with Division 1. Include copies of manufacturer's specifications for fabrication and installation including certifications, data and test reports substantiating that products comply with requirements.
- B. Submit shop drawings showing sizes and complete details of doors. Include details of core and edge construction, trim for openings and similar components. Include finishing specifications for doors to receive factory-applied shop finish.
- B. Provide a schedule of doors and frames using same reference designations for details and openings as indicated on the Contract Drawings.
- C. Samples: Submit manufacturer's door sample composed of door face sheet, core, framing and finish.
- D. Color samples: Submit manufacturer's sample of standard colors for door face and frame
- E. Certified test reports indicating the acoustical performance of the door meets or exceeds the Sound Transmission Class (STC) performance stated in One-Third Octave Band Transmission Loss performance shown in the Acoustical Performance Schedule below. Test data shall be produced

from an accredited independent acoustical laboratory which is a member of NVLAP (National Volunteer Laboratory Accreditation Program). Reports should indicate that the test was performed on the doors and frames of the type to be supplied in conformance with the requirements of test method ASTM Standard E90-02 (or more recent), Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

- E. Furnish to the Owner an Owners Operation and Maintenance Manual in accordance with Division 1. The manual shall consist of maintenance instructions for doors and frames; catalog pages for each product; name, address and phone number of the local representative of each manufacturer; and copy of the approved shop drawings.

1.05 PRODUCT HANDLING

- A. Doors are to be stacked flat in a dry and protected area in original cartons prior to installation. Provide blocking or staging to protect door surfaces. Do not drag doors across one another. Lift doors and carry them into position. Identify each door with individual opening designations, as indicated on the approved shop drawings, using concealed markings.

1.06 WARRANTY

- A. Submit written agreement in door manufacturer's standard form signed by manufacturer, Installer and Contractor, agreeing to repair or replace defective doors which have separated, delaminated from the core, expansion of the core, or otherwise failed due to defects in material and workmanship, improper installation or corrosion from a specified environment, for a period of not less than ten (10) years.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Marshall/Vega Corporation, Marshall, Arkansas.
 2. Special-Lite, Inc., Decatur, Michigan – Model AF-100 (Basis of Design Product).
 3. Tiger Door, LLC.

2.02 FIBERGLASS REINFORCED PLASTIC (FRP) DOORS

- A. FRP Door Construction: Pultruded as one monolithic panel with integral stiles:
 1. Door Thickness: 1-3/4".
 2. Stiles: Seamless 9/16" thick solid FRP.
 3. Top Rail: 6" pultruded tube profile designed to fit flush and be chemically welded inside of door cavity.
 4. Bottom Rail: Standard pultruded inverted U channel designed to fit flush and be chemically welded inside the door which allows doors to be field trimmed.
 5. Core: Polyurethane foam, minimum 6 pcf density.
 6. Face Sheet: Smooth, pultruded FRP integral to construction of door. Door to be pultruded as one monolithic panel.
 7. Cutouts: Manufacture doors with cutouts for required vision lites, louvers, and panels.

8. Hardware: Pre-machine doors in accordance with templates from specified hardware manufacturers. Surface mounted closures will be reinforced for but not prepped or installed at factory.
9. Reinforcements: No metallic reinforcements will be allowed.

2.03 FRP FRAMES:

- A. ¼” thick pultruded fiberglass open throat with return, factory fabricated, with 2” face.
- B. Integral Door Stops: 5/8” x 2-1/4”.
- C. Frame Assembly: Standard knock down.
- D. Frame Member to Member Connections: Corners mitered with 4” x 4” x 3/8” pultruded FRP angle reinforcement with interlocking pultruded FRP brackets. All member to member connections knocked down at factory unless chemically welded at factory requested. Provide hairline butt joint appearance.
- E. Reinforcements: ¼” thick pultruded FRP chemically welded to frame at all hinge, strike, and closer locations.

2.04 ACCESSORIES:

- A. Fasteners: Aluminum, nonmagnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.
 1. Do not use exposed fasteners.
- B. Brackets and Reinforcements: Manufacturer’s high strength aluminum units where feasible, otherwise nonferrous stainless steel.
- C. Bituminous Coating: Cold applied asphaltic mastic, compounded for 30 mil thickness per coat.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify upon delivery that all doors and frames comply with the approved shop drawings and meet the indicated requirements for type, size, location and swing. Examine each opening for conditions that would prevent the proper application of doors, frames and related items. Do not proceed until defects are corrected.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer’s instructions and approved shop drawings; set frames plumb, square, level, and aligned to receive doors.
- B. Anchor frames to adjacent construction in strict accordance with recommendations and approved shop drawings and within tolerances specified in manufacturer’s instructions.
 1. Seal metal-to-metal joints between framing members using good quality elastomeric sealant.
- C. Hang doors with required clearances as follows:
 1. Hinge and Lock Stiles: 0.125 inch.
 2. Between Meeting Stiles: 0.250 inch.
 3. At Top Rails: 0.125 inch.

- 4. Between Door Bottom and Threshold: 0.125 inch.
- D. Adjust doors and hardware to operate properly.
- E. Install hardware for doors of this section.
- F. Installation of door hardware is specified in Section 08710.

3.03 CLEANING

- A. Upon completion of installation thoroughly clean door and frame surface in accordance with AAMA 609.
- B. Do not use abrasive, caustic or acid cleaning agents.

3.04 PROTECTION

- A. Protect products of this section from damage caused by subsequent construction until substantial completion.
- B. Repair damage or defect products to original specified condition in accordance with manufacturer's recommendations.
- C. Replace damaged or defective products that cannot be repaired to the Architect's acceptance.

END OF SECTION

SECTION 08710 - DOOR HARDWARE

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. Mechanical door hardware for the following:
 - a. Swinging doors.
 - 2. Cylinders for door hardware specified in other Sections.
- B. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 80 - Fire Doors and Windows.
 - 4. NFPA 101 - Life Safety Code.
 - 5. NFPA 105 - Installation of Smoke Door Assemblies.
 - 6. Michigan State Building Code, Local Amendments.
- C. Standards: All hardware specified herein shall comply with the following industry standards:
 - 1. ANSI/BHMA Certified Product Standards - A156 Series
 - 2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.03 SUBMITTALS, GENERAL

- A. General: Submit all action submittals (except Samples for Verification) and informational submittals required by this Section concurrently.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 - 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.

- e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
- 1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - 2. Electrical Coordination: Coordinate with related Division 26 Electrical Sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- 1. Hinges.
 - 2. Exit devices and auxiliary items.
 - 3. Lock cylinders.
 - 4. Construction cores.
 - 5. Keying system/keys.
 - 6. Operating trim.
 - 7. Surface closers.
 - 8. Wall- and floor-mounted stops.
 - 9. Door gasketing.
 - 10. Thresholds.

- B. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - 2. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e. Fastenings and other pertinent information.
 - f. Explanation of abbreviations, symbols, and codes contained in schedule.
 - g. Mounting locations for door hardware.

- C. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Architectural Hardware Consultant.
- B. Product Certificates: For electrified door hardware, from the manufacturer.
 - 1. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.
- B. Warranty: Executed special warranty specified in this Section.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 - 1. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 - 2. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:

1. For door hardware, an Architectural Hardware Consultant (AHC).
- C. Source Limitations: Obtain each type of door hardware from a single manufacturer.
- D. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.
- E. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.
- F. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- G. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, ICC/ANSI A117.1 and building code in effect for Project.
 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
 4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.
- H. Preinstallation Conference: Conduct conference at Project site.
 1. Inspect and discuss preparatory work performed by other trades.
 2. Inspect and discuss electrical roughing-in for electrified door hardware.
 3. Review sequence of operation for each type of electrified door hardware.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.09 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- C. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.
 - a. Exit Devices: Two years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products or products equivalent in function and comparable in quality to named products.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
 - 3. Electric Locking Hardware: Exit hardware shall always remain fully operational manually regardless of the status of electric latch.

- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
 2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.02 HINGES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity, unless otherwise indicated:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
 - 1) Out-swinging exterior doors.
 - 2) Out-swinging access controlled doors.
 - 3) Out-swinging lockable doors.
 5. Acceptable Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products (MK).

2.03 DOOR OPERATING TRIM

- A. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified below or in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.

4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - a. Acceptable Manufacturers:
 - 1) Rockwood Manufacturing (RO).
 - 2) Trimco (TC).

2.04 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinders: Original manufacturer cylinders complying with the following:
 1. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 2. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 3. Keyway: Match Facility Standard.
- D. Keying System: Match existing key system or provide new patented cylinder listed in 2.4.D. Each type of lock and cylinders to be factory keyed. Conduct specified "Keying Conference" to define and document keying system instructions and requirements. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner. Incorporate decisions made in keying conference, and as follows:
 1. Existing System: Grand master key locks to Owner's existing system.
- E. Key Quantity: Provide the following minimum number of keys:
 1. Top Master Key: One (1)
 2. Change Keys per Cylinder: Two (2)
 3. Master Keys (per Master Key Group): Two (2)
 4. Grand Master Keys (per Grand Master Key Group): Two (2)
 5. Construction Keys (where required): Ten (10)
 6. Construction Control Keys (where required): Two (2)
 7. Permanent Control Keys (where required): Two (2)
- F. Construction Keying: Provide construction master keyed cylinders or temporary keyed construction cores where specified. Provide construction master keys in quantity as required by project Contractor. Replace construction cores with permanent cores. Furnish permanent cores for installation as directed under specified "Keying Conference".
- G. Key Registration List: Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
- H. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
 1. Acceptable Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

2.05 MECHANICAL LOCKS AND LATCHES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified mortise locksets furnished in the functions as specified in the Hardware Sets. Locksets to be manufactured with a corrosion resistant, stamped 12 gauge minimum formed steel case and be field-reversible for handing without disassembly of the lock body. Lockset trim (including knobs, levers, escutcheons, roses) to be the product of a single manufacturer. Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel bolt for deadbolt functions.
 - 1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (COR) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – 8200 Series.
 - c. Dormakaba (DOR) – E-Plex 2000 Series
- B. Lock Trim Design: As specified in Hardware Sets.
- C. Lock Functions: As indicated in door hardware schedule.
- D. Lock Backset: 2-3/4 inches, unless otherwise indicated.
- E. Lock Trim:
 - 1. Levers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – 8200 Series.
 - 2. Dummy Trim: Match lever lock trim.
- F. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
- G. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
 - 4. Dustproof Strikes: BHMA A156.16.

2.06 EXIT DEVICES AND AUXILIARY ITEMS

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
 - 1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
 - 2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

- a. Fire Exit Removable Mullions: Provide keyed removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions to be used only with exit devices for which they have been tested.
 - 3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 - 4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is not acceptable except in any case where the door light extends behind the device as in a full glass configuration.
 - 5. Flush End Caps: Provide heavy weight impact resistant flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
 - 6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty trim with cold forged escutcheons, beveled edges, and four threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets. Provided free-wheeling type trim where indicated.
 - b. Where function of exit device requires a cylinder, provide an interchangeable core type keyed cylinder (Rim or Mortise) as specified in Hardware Sets.
 - 7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 - 8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 - 9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 - 10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include:
 - a. Von Duprin; an Ingersoll-Rand company.

2.07 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
 - 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. Best Access Systems; Div. of Stanley Security Solutions, Inc. (owner provided/contractor installed)
- B. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.08 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. Master Key System: Change keys and a master key operate cylinders.
 2. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
 3. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - b. Re-key Owner's existing master key system into new keying system.
- B. Keys: Nickel silver.
1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."
 2. Quantity: In addition to one extra key blank for each lock, provide the following:
 - a. Cylinder Change Keys: Three.
 - b. Master Keys: Five.
 - c. Grand Master Keys: Five.

2.09 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; stainless steel, unless otherwise indicated.
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. Hager Companies.
 - b. IVES Hardware; an Ingersoll-Rand company.
 - c. Rockwood Manufacturing Company.

2.10 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.

2.11 SURFACE CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
 2. Standards: Closers to comply with UL-10C and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
 4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
 5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 - a. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.

- b. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
 - c. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.
 - d. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door Hardware Sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
- 1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC8000 Series.
 - b. LCN Closers (LC) - 4040XP Series.
 - c. Sargent Manufacturing (SA) - 351 Series.
 - d. Norton Door Controls (NO) - 7500 Series.
 - e. Yale Locks and Hardware (YA) - 4400 Series.

2.12 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 - 1. Acceptable Manufacturers:
 - a. Rockwood Manufacturing (RO).
 - b. Trimco (TC).

2.13 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated. All seals and weatherstrip seals to be mechanically fastened to the frame; adhesive fastening is not allowed.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Acceptable Manufacturers:
 - 1. Pemko Manufacturing (PE).
 - 2. Reese Enterprises, Inc. (RS).
 - 3. Zero International (ZE).

2.14 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
 - 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. Hager Companies.
 - b. IVES Hardware; an Ingersoll-Rand company.
 - c. Rockwood Manufacturing Company.

2.15 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors.
5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.16 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.02 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

3.03 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 2. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 3. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.04 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.05 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.07 DOOR HARDWARE SCHEDULE

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. RF - Rixson
3. RO - Rockwood
4. AD - Adams Rite
5. SA - Sargent
6. YA - Yale
7. PE - Pemko
8. SU - Securitron
9. JN - Johnson

- C. HARDWARE SCHEDULE

SET NO. 1

1 EA	CONTINUOUS HINGE	FM	DFM	PEM
1 EA	MORTISE CLASSROOM FUNCTION	ML2073 - NSA X CLS7	626	COR
1 EA	CYLINDER			
1 EA	SURFACE CLOSER (PA)	4111-SHCUSH WMS 30	695	LCN
1 EA	MOUNTING PLATE (PA)	4110-18 WMS	695	LCN
1 EA	KICK PLATE	K1050 X 4BE X 10 X 34	US32D	ROC
1 EA	DOOR SWEEP	C627DKB 36"	710	NGP
1 EA	1/2" X 5" THRESH	425 76" SSMSLA	719	NGP
1 EA	GASKETING	305SSR		PEM
1 EA	DRIP CAP	346D	A	PEM
1 EA	LATCH PROTECTOR	321	STAINLESS	ROC

SET NO. 2

2 EA	CONTINUOUS HINGE	FM	DFM	PEM
1 EA	MORTISE CLASSROOM FUNCTION	ML2073 - NSA X CLS7	626	COR
1 EA	CYLINDER			
2 EA	SURFACE BOLTS	585-12	26d	ROC
2 EA	SURFACE CLOSER (PA)	4111-SHCUSH WMS 30	695	LCN
2 EA	MOUNTING PLATE (PA)	4110-18 WMS	695	LCN
1 EA	COORDINATOR	2600 SERIES	BLK	ROC
2 EA	KICK PLATE	K1050 X 4BE X 10 X 34	US32D	ROC
2 EA	DOOR SWEEP	C627DKB 36"	710	NGP
1 EA	1/2" X 5" THRESH	425 76" SSMSLA	719	NGP
1 EA	GASKETING	305SSR		PEM
1 EA	DRIP CAP	346D	A	PEM
1 EA	LATCH PROTECTOR	321	STAINLESS	ROC
1 EA	ASTRAGAL	355CS	CLEAR	PEM

END OF SECTION

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Field painting as shown and/or herein required. See specific items not requiring field painting under Work Not Included.
- B. In general, exposed surfaces of factory and/or shop-primed work that are delivered to Site without a final finish shall be painted. The shop priming and intermediate shop coatings shall not be considered as included in the number of field coats specified under Part 2, Field Painting Systems Article, Finish Paints paragraph in this Section.
- C. Ferrous metal surfaces, excluding stainless steel surfaces that will be exposed in the completed Work, shall be sandblasted either at the point of fabrication or under this Section prior to placement of primers. Field fabrication, including welds and cuts, shall be sandblasted, primed, and painted as herein specified.
- D. Ferrous metal items that will be in contact with precast concrete slabs, masonry, etc., shall be finish painted.
- E. Bruises, mars, and/or scratches in the shop painting due to handling, shall be immediately touched up in the field by CONTRACTOR prior to any storage or installation.
- F. Painting of piping includes pipe hangers, valves, and piping accessories, and also includes surfaces that will be in contact with piping supports. ALL PIPING SHALL BE COMPLETELY PAINTED.
- G. Altered existing Work or damaged surfaces that are a result of the revisions shall be painted under this item of Work. The finishes shall match the existing adjacent coatings.
- H. Miscellaneous equipment shipped to Site with factory-applied coatings as follows, shall be painted under this Work as specified:
 - 1. No Factory Finish: Surface preparation, priming, and finish painting.
 - 2. Prime Coat: Surface preparation, touch-up, and finish painting.
 - 3. Intermediate Coat: Surface preparation, touch-up, and finish painting.
 - 4. Pre-finished Equipment: Touch-up as required. Equipment manufacturer shall furnish necessary touch-up paint.
 - 5. Factory finish coats, not matching the approved finish colors, that are provided in lieu of the shop prime specified shall be properly prepared and receive a final field coat to match the adjacent related Work.
- I. Painting as called for on Drawings is for guidance only and does not limit the requirements for painting.
- J. Work Not Included: Unless specifically called for on Drawings or specified in this Section, the following are not included:
 - 1. Nonferrous metals and stainless steel, except copper and brass.
 - 2. Manufacturer's name and identification plates.

1.02 REFERENCES

- A. ASTM International:
1. ANSI (American National Standards Institute)
 2. NSF Standard 61 – Drinking Water Components – Health Effects
 3. AWWA (American Water Works Association)
 4. OSHA (Occupational Safety & Health Administration)
 5. NFPA (National Association of Pipe Fabricators)
 6. SSPC (Society for Protective Coatings)
 - a. SP COM – Surface Preparation Commentary for Steel and Concrete Substrates.
 - b. SP-1 – Solvent Cleaning.
 - c. SP-2 – Hand Tool Cleaning.
 - d. SP-3 – Power Tool Cleaning.
 - e. SP-5- White Metal Blast Cleaning.
 - f. SP-6 – Commercial Blast Cleaning.
 - g. SP -7 – Brush-Off Blast Cleaning.
 - h. SP-10 – Near-White Blast Cleaning.
 7. NACE International.
- B. All paints and materials which comes into contact with raw water shall conform to AWWA standards and/or Michigan Department of Environment, Great Lakes, and Energy regulations as they may apply to potable water and shall be NSF (Standard 61) approved. The manufacturer furnishing the coating material shall furnish certification to the Owner that the materials meet these agency provisions.

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. Listing of all materials proposed for use on Work, including designation of the area, primer required, or purpose.
 2. Specification data sheets included for each specific material proposed.
 3. Application instructions included for each specific material proposed.
 4. Color samples
 - a. Manufacturer's standard physical color charts for color selection by Owner. Compliance with all other requirements is the exclusive responsibility of the Contractor.
 - b. Samples of each finish and color shall be submitted to the Owner for approval before any work is started.
 - c. Samples shall be prepared so that an area of each sample indicates the appearance of the various coats. For example, where three (3) coat work is specified, the sample shall be divided into three (3) areas:
 - d. One (1) showing the application of one (1) coat only.
 - e. One (1) showing the application of two (2) coats.
 - f. One (1) showing the application of all three (3) coats.
 - g. Such samples when approved in writing shall constitute a standard, as to color and finish only, for acceptance or rejection of the finish work.
 - h. For piping, valves, equipment and miscellaneous metal work, provide sample chips or color charts of all paint selected showing color, finish, and general characteristics.
 - i. Rejected samples shall be resubmitted until approved.

5. Shop Drawings, Working Drawings, manufacturer's specifications, and data on the proposed paint systems and detailed surface preparation, application procedures and dry film thickness (DFT).
- B. Furnish ENGINEER, for approval, a schedule for all painting as called for on Painting Schedule and Piping Color Code and Identification subsection.
1. The Contractor shall submit for approval a complete typewritten Schedule of Painting Operations within 90 days after the Notice to Proceed. This Schedule is imperative so that the various fabricators or suppliers may be notified of the proper prime coat to apply. It shall be the Contractor's responsibility to properly coordinate the fabricators' or suppliers' surface preparation and painting operations with these Specifications. This Schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and the number of coats in order to achieve the specified dry film thickness, and color charts. When the Schedule has been approved, the Contractor shall apply all material in strict accordance with the approved Schedule and the manufacturer's instructions. Wet and dry paint film gauges may be utilized by the Owner to verify the proper application while work is in progress.
 2. It is the intent of this Section that as much as possible all structures, equipment, and piping utilize coating systems specified herein supplied by a single manufacturer. All exceptions must be noted on the Schedule. For each coating system, only one (1) manufacturer's product shall be used.
- C. The Contractor shall submit to the Owner, immediately upon completion of the job, certification from the manufacturer indicating that the quantity of each coating purchased was sufficient to coat all surfaces, in accordance with the requirements of this Section. Such certification shall make reference to square footage figures provided to the manufacturer by the Contractor.
- D. Product Data:
1. Include description of physical properties of products including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations.
 - a. Regulatory requirements: Submit data concerning the following:
 - 1) VOC limitation
 - 2) Coatings containing lead compounds and PCBs.
 - 3) Abrasives and abrasive blast cleaning techniques and disposal.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer Instructions: Submit special surface preparation procedures and substrate conditions requiring special attention.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Qualifications Statements:
1. Submit qualifications for manufacturer and applicator.
 2. Submit manufacturer's approval of applicator.
- I. Operation and Maintenance Data: Submit information on cleaning, touchup, and repair of painted and coated surfaces.

- J. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.
 - 1. All paint and coatings work performed under these Specifications shall be guaranteed by the coatings applicator for 100 percent of the total coated area for both materials and labor against failures during the warranty period.
 - 2. Failure under this warranty shall include flaking, peeling, or delaminating of the coating due to aging, chemical attack, or poor workmanship; but it shall not include areas which have been damaged by unusual chemical, thermal, or mechanical abuse.

1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.
- B. CONTRACTOR's Responsibility: It shall be CONTRACTOR's responsibility to check the compatibility of painting materials proposed for this Contract. CONTRACTOR shall coordinate this Work with other trades to ensure compliance with these Specifications.
- C. Acceptability of materials and performance shall be determined by ENGINEER.
- D. Painting shall be accomplished by experienced painters specializing in industrial painting familiar with all aspects of surface preparations and applications required for this project. Work shall be done in a safe and workmanlike manner.
- E. Testing or certification may be required to aid ENGINEER's determination of fitness.
 - 1. Expense of testing and certification when required and, unless noted otherwise in the Contract Documents, shall be borne by CONTRACTOR.
 - 2. If destructive testing is required, CONTRACTOR shall repair damaged area. Expense of repair shall be borne by CONTRACTOR.
- F. Request, in writing, a review of each coat by ENGINEER of first finished surface of each type of color, texture, and workmanship. First acceptance of each type and color shall be visibly labeled by ENGINEER with removable labels as Project standard for that type and color of item. Labels shall remain in place until Work is finished.
 - 1. For spray application, paint a surface of 100-square-foot as Project standard.
 - 2. For roller application, apply a 36-square-foot mock-up as Project standard.
- G. All Work may be inspected as to proper surface preparation, pre-treatment, priming, dry film thickness, curing, color, and workmanship. CONTRACTOR shall supply the following applicable standards, test methods, and inspection equipment:
 - 1. SSPC-VIS-1 photographic blast cleaning standards.
 - 2. Inspectors wet film gauge.
 - 3. Inspectors magnetic dry film thickness gauge.
 - 4. Tinkor Razor M-1 low voltage Holiday Detector.
 - 5. Marke 5 Tooke Gauge.

1.05 FIELD PAINTING SUBMITTAL SCHEDULE

- A. Furnish ENGINEER, for approval, prior to commencing any painting, a Schedule similar to that below:

City of Kalamazoo
Water System

Corrosion Control Improvements

09900-4

November 2023

FIELD PAINTING SUBMITTAL SCHEDULE

<u>Item and/or Location</u>	<u>Type Material</u>	<u>Coverage per Coat</u>	<u>Paint Manufacturer</u>
Pre-treatment			
Primers			
Interior nonsubmerged metal, epoxy coated			
Interior PVC, epoxy coated			

1.06 PROJECT MEETING

- A. Prior to ordering any materials under this Section, CONTRACTOR, ENGINEER, painting subcontractor, and paint manufacturer's representative shall attend a progress meeting to review Work to be performed under this Section.

1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in manufacturer's original, unopened packages and containers, bearing manufacturer's name and label and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Federal Specification number, if applicable.
 - 4. Manufacturer's stock number and date of manufacture.
 - 5. Contents by volume for pigment and vehicle constituents.
 - 6. Thinning instructions.
 - 7. Application instructions.
 - 8. Color name and number.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F (7 degrees C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.09 PROJECT CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).

- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C).
- C. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Painting Materials:
 - a. PPG Industries, Pittsburgh, PA 15222.
 - b. Porter International, Louisville, KY 40203.
 - c. Sherwin-Williams Company, Cleveland, OH 44101.
 - d. Tnemec, North Kansas City, MO 64141.
 - 2. Dry Film Thickness Gauge:
 - a. Elcometer.
 - b. Nordstrom.

2.02 MATERIALS

- A. Painting materials shall be those as herein specified under "Field Painting Systems" Article.
- B. The specification designations, manufacturers and/or trade names herein are intended to establish a quality and standard for the materials used.
- C. Colors and sheen, where not specified, shall be selected by ENGINEER.
- D. Oil, turpentine, and other thinners used in the finishing Work shall meet the requirements of the latest appropriate ASTM.

2.03 FIELD PAINTING SYSTEMS

- A. The following systems may vary from the coverages and mil thickness shown if recommended by paint manufacturer and approved in writing by ENGINEER. Number of coats shall be as required to obtain the mil thickness specified.
- B. If no pre-treatment is required by paint manufacturer, the surfaces shall be solvent cleaned (SSPC-SP1); otherwise the surfaces shall be pre-treated as follows:
- C. Field Priming and Sealing:
 - 1. Metal Primer: Apply 1 coat of a universal rust-inhibitive primer which can be used on both submerged and nonsubmerged ferrous metal and has the ability to accept alkyds, epoxy, vinyl,

coal tar, chlorinated rubber, emulsion, coal-tar epoxies, epoxy ester, asphalt, and phenolic paints as finish coats. Apply at the rate of 1.5 dry mils or as recommended by manufacturer.

2. Sealant for Bituminous Coated Surfaces: Apply 2.5 dry mils of synthetic alcohol-soluble resin and titanium pigment, or as recommended by manufacturer in writing and approved by ENGINEER.

D. Finish Paints:

1. Interior Nonsubmerged Metal: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils per coat.
2. Interior PVC, Epoxy Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils per coat.

2.04 PIPING COLOR CODE AND IDENTIFICATION

- A. CONTRACTOR shall furnish ENGINEER for approval, prior to commencing any painting, a Schedule showing colors and markings proposed. Owner reserves the right to select non-standard colors for paint systems specified within ability of paint manufacturer to produce such non-standard colors. Provide such colors at no additional expense to Owner.
- B. The pipe color code and identification nomenclature shall be as designated on the Piping Color Schedule. CONTRACTOR shall contact ENGINEER for an approved color and appropriate name if no designation is Scheduled.
- C. Pipe markings and banding shall be placed on exposed pipe by stenciling or other method as approved by ENGINEER. The markings shall include an appropriate name and direction of flow arrow. The markings shall be located at intervals not to exceed 15 feet and shall occur at least once in every room unless otherwise approved by ENGINEER. Letters and arrows shall be white-on-dark colored surfaces and black-on-light colored surfaces, shall be proportioned to the size of the pipe, and shall be located in an area that will facilitate readings.

Size of Identification Letters	
Outside Diameter of Pipe or Covering (inches)	Size of Letters (inches)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
over 10	3-1/2

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. Workmanship shall be of the best grade with materials evenly spread and smoothly flowed on, without runs or sagging of materials. No adulterations or changes of proportions shall be permitted

unless recommended by manufacturer and approved by ENGINEER. Paint shall be applied in strict conformity with the manufacturer's directions.

3.02 EXAMINATION

- A. It is the responsibility of the painter to thoroughly inspect all surfaces prior to the commencement of Work to determine if the Work is ready to be prepared and painted.
- B. Report in writing to ENGINEER, all conditions that may potentially affect the application.
- C. Do not commence until such defects have been corrected.
- D. Start of painting shall be construed as the applicator's acceptance of surfaces and conditions within a particular area.

3.03 PREPARATION

- A. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in places that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, removed items shall be reinstalled by workers skilled in the trades involved.
 - 1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- B. Surface Preparation: Prior to applying specific finishes, exposed surfaces requiring field painting shall be properly filled, scraped, sanded, etched, brushed, and/or cleaned as required to provide surfaces free from dirt, loose crystals, rust, scale, oil, and grease.
 - 1. Surfaces shall be prepared in accordance with manufacturer's recommendations. Surfaces shall be inspected and accepted by CONTRACTOR before coatings are applied.
 - 2. No change in treatment of surfaces shall be permitted unless recommended by manufacturer and approved by ENGINEER.
- C. Metals Preparation: Submerged ferrous metals shall have all welds ground smooth to remove spatter, recesses, pinholes, and protrusions. Metal shall be degreased in accordance with SSPC-SP1 and abrasive blast cleaned in accordance with SSPC-SP10, "Near White Abrasive Blast Cleaning."
 - 1. Nonsubmerged ferrous metals shall be degreased in accordance with SSPC-SP1 and sandblasted in accordance with SSPC-SP6, "Commercial Abrasive Blast Cleaning."
 - 2. Nonferrous metals shall be degreased in accordance with SSPC-SP1.
- D. PVC Preparation: No special surface treatment is required. Surface shall be clean and dry.
- E. Drywall Construction: Joint compound material shall be sanded to provide a smooth flat surface. Remove dust from surface by wiping with clean rags or other means.

3.04 FIELD PRIMING AND SEALING

- A. In general, metal surfaces requiring field painting shall receive a priming coat before shipment from the shop. Such priming coats shall be compatible to subsequent applied coats.

1. Wherever Work requiring field painting bears no priming coat, or has a damaged shop coat, it shall have the surface prepared as specified and shall receive an approved priming coat, applied before and in addition to the finish coats required.
2. Concrete surfaces, requiring field painting, shall be primed and sealed if recommended by the manufacturer of the finish paint.

3.05 PAINT MATERIALS PREPARATION

- A. Carefully mix and prepare paint materials in accordance with manufacturer's directions.
 1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.06 APPLICATION

- A. First Field Coat: The first field coat shall be the best suited for use with the surfaces to be covered and with the final coats. Whenever the finish color permits, the first coat shall be slightly tinted to the end that complete coverage of the final coat may be assured.
- B. Finish Coats: Apply in a uniform manner and of the mil thicknesses as specified. Where the mil thickness recommended by manufacturer is in conflict with that thickness specified, the proposed thickness shall be submitted in writing by manufacturer, supported by evaluative data sheets, subject to approval by ENGINEER. Where the mil thickness is omitted, it shall be as recommended by the manufacturer to give an excellent surface finish. Finished surface thickness shall be subject to spot checking by ENGINEER using a wet and/or dry gauge. Deficiencies in required thickness shall be corrected by addition of extra coats at no additional cost to OWNER.
- C. Thinners: Those recommended by manufacturer shall be used and the amounts shall not exceed recommendations by manufacturer.
- D. Caution: Paints shall not be applied on damp surfaces or on preceding coats not thoroughly dried, and shall not be applied on outside surfaces in extreme cold, frosty, foggy, or damp weather unless permitted by the materials manufacturer in the standard application specification. Materials shall not be applied when the temperature is below 50 degrees F. Drying time between coats shall be as recommended by paint manufacturer.
- E. Spraying: Spraying will be permitted only for such Work as approved by ENGINEER.
 1. Spraying equipment shall be of a type and capacity adapted to Work and shall be subject to ENGINEER's approval. Spraying equipment, including temporary rigid piping, flexible hose, nozzles, etc., shall be kept in such condition as will ensure against breakdowns and stoppage.
 2. Particular care shall be exercised to prevent the soiling or damaging of adjacent Work. Brushing shall immediately follow the spraying when necessary to eliminate wrinkling, blistering, and air holes.
- F. Painting Existing Surfaces: Repainted existing surfaces shall receive a finish to match the existing Work. Where the existing surfaces are irregular, they shall be made smooth with an approved leveler coat.

3.07 PROTECTION, SPECIAL PRECAUTIONS, AND CLEAN UP

- A. Reasonable care shall be used to prevent splattering. Drop cloths and masking materials shall be used to protect surfaces and parts of equipment that are not required to be painted under the Contract. Splashes, drippings, and stains shall be thoroughly removed upon the completion of Work.
- B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their Work after completion of painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- C. Lighting fixtures shall be covered and protected, or removed and replaced upon completion of Work. Electric switch plates, surface hardware, and similar equipment shall be removed, protected and replaced.
- D. Materials shall be stored and mixed in a well-ventilated location as designated or approved by ENGINEER. Paints and related materials shall be stored in an area that is protected in accordance with NFPA Bulletin No. 101. They shall be kept in a neat condition and shall be sealed or covered when not in use. Empty containers shall not be allowed to accumulate on the premises. Oily waste rags, etc., shall be collected each day and destroyed or stored in a tightly covered metal container.
- E. Comply with manufacturer's recommendations regarding environmental conditions under which coatings and coat systems can be applied.
- F. During surface preparation, CONTRACTOR shall take all precautions necessary to protect related Work. Equipment items and Work areas shall be tightly covered so as not to be damaged by the painting operation. Special attention shall be made to protect equipment items during sandblasting operations.
- G. CONTRACTOR shall be responsible for clean up of painting materials upon completion of Work.
- H. As soon as painting Work is accepted by CONTRACTOR, it shall become its responsibility for protection, final cleaning, and touch-up.

Piping Color Schedule - Water Treatment

Type	Base Color	Bands*
WATER LINES		
Finished or Potable	Dark Blue	
Service or Nonpotable	Light Blue	Black
CHEMICAL LINES		
Poly-orthophosphate	Light Green	Red
WASTE LINES		
Sewer (Sanitary, Discharge or Other)	Dark Gray	
Drainage and Vent	**Black	
MISCELLANEOUS ITEMS		
Sample Piping	To match piping sampled	
Electrical Conduit	**Light Gray	

* Banding shall be 6 inches wide at 30-inch c/c.

** When exposed to the building interiors above the basement areas, the color shall match the adjacent finish.

END OF SECTION

SECTION 09960 - SPECIAL COATINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Application of special coating systems to items and surfaces scheduled, including surface preparation, prime coats, and topcoats for the surfaces indicated on drawings.
- B. Types of special coating systems required for the Project include:
 - 1. Special Coatings for Interior Use:
 - a. Flake-filled, Catalyzed Vinylester System (with Resin Topcoat where indicated) (SC1, SC2, SC3, and SC4 on drawings).

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: Manufacturer's technical information including basic materials analysis and application instructions for each coating material specified.
 - a. List each material and cross-reference the specific coating and finish system and application. Identify each material by the manufacturer's catalog number and general classification.
 - b. Certification by manufacturer that products submitted and supplied comply with local regulations controlling use of volatile organic compounds (VOC).
 - c. Provide details for each anticipated condition, including vertical and horizontal termination, corner, and all flashing details.
 - 2. Installer Qualifications: The special coatings applicator shall submit the following:
 - a. Installer's Project References: Submit 5 projects, of similar size and construction type, in writing to exhibit the experience level necessary to perform the Work. List project location, size, coating type, Owner contact, and telephone number.
 - b. Certification of Applicator's Supervisor: Submit for applicator's supervisor a certificate indicating completion of Manufacturer's Contractor Training program.
 - 3. Samples: Prior to beginning Work, ENGINEER will furnish color chips for surfaces to be coated. Use representative colors when preparing samples for review. Submit samples for review of color and texture only. Provide a list of material and application for each coat of each finish sample.
 - a. Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate. Resubmit samples as requested until the required sheen, color and texture is achieved.
 - b. Provide stepped samples defining each separate coat, including fillers and primers. Use representative colors when preparing samples for review. Resubmit until the required sheen, color, and texture are achieved. Provide a list of materials and applications for each coat of each sample. Label each sample.
 - c. Concrete: Provide two 4-inch-square samples for each type of color and finish; define prime and finish coats.

1.03 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and undercoat material produced by the same manufacturer as the finish coats. Use only thinners recommended by the manufacturer and only within recommended limits.
- B. Installer Qualifications:
 - 1. Use Installer who is authorized, approved, or licensed by special coating manufacturer to install manufacturer's products and is experienced in the application of the specified special coating for a minimum of 3 years on projects of similar size and type.
 - 2. Installer's Supervisor: Employ a supervisor during all phases of the Work that has successfully completed Manufacturer's Contractor Training program.
- C. Coordination of Work: Review sections in which other coatings are provided to ensure compatibility of the total systems for various substrates. Upon request, furnish information on characteristics of specified finish materials to ensure that compatible prime coats are used.
 - 1. Notify ENGINEER of problems anticipated using the coatings systems specified.
- D. Field Mock-ups: On actual wall surfaces and other interior and exterior components, duplicate coating finishes of prepared samples. Provide full-coat finish samples on at least 100 square feet of surface until required sheen, color, and texture are obtained; simulate finished lighting conditions for review of in-place Work.
 - 1. Final acceptance of colors shall be from Site-applied samples.
 - 2. ENGINEER will select one room, area, or surface to represent surfaces and conditions for each type of coating and substrate to be coated. Apply coatings in this room, area, or surface in accordance with Schedule on Drawings or as specified. After finishes are accepted, this room, area, or surface will be used for evaluation of coating systems of a similar nature.
- E. Material Quality: Provide the best quality grade of the various coatings as regularly manufactured by acceptable coating manufacturers. Materials not displaying manufacturer's identification as a best-grade product will not be acceptable.
 - 1. Proprietary names used to designate colors or materials are not intended to imply that products of named manufacturers are required to the exclusion of equivalent products of other manufacturers.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in the manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label and the following information:
 - 1. Name or title of material.
 - 2. Federal Specification number, if applicable.
 - 3. Manufacturer's name, stock number, and date of manufacture.
 - 4. Contents by volume for major pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
 - 8. Handling instructions and precautions.
- B. Store materials not in actual use in tightly covered containers at a minimum ambient temperature of 45 degrees F (7 degrees C) in a well-ventilated area. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary precautionary measures to ensure that personnel and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing, and application of coatings.

1.05 PROJECT CONDITIONS

- A. Apply coatings only when the temperature of surfaces to be coated and surrounding air temperatures are above 45 degrees F (7 degrees C), unless otherwise permitted by manufacturer's printed instructions.
- B. Do not apply coatings in snow, rain, fog or mist, or when the relative humidity exceeds 85 percent, or at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces unless otherwise permitted by manufacturer's printed instructions. Allow wet surfaces to dry thoroughly and attain the temperature and conditions specified before proceeding with or continuing the coating operation.
- C. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and the temperature within the area can be maintained within limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Coatings:
 - a. Carboline Company.
 - b. Ceilcote Corrosion Control Products.
 - c. C.I.M. Industries, Inc.
 - d. Dudick, Inc.
 - e. KCC Corrosion Control Co., Ltd.
 - f. Sherwin-Williams Company (Control Tech).
 - g. Tnemec Company.

2.02 INTERIOR COATING MATERIALS

- A. Glass Flake-filled Vinylester Lining (with resin topcoat where required): Provide manufacturers complete lining system comprising glass flake-filled, catalyzed vinylester (with resin topcoat where required), spray applied in a minimum of 2 coats to achieve 30 to 50 mils dry film thickness minimum and a moisture barrier primer (Dudick Vapor Stop).
 1. Materials:
 - a. SC1: Not used.
 - b. SC2:
 - 1) Core-Cote VEN GF (Sherwin-Williams Company).
 - 2) Flakeline 222GF (Ceilcote Corrosion Control).
 - 3) Protecto-Coat 900 (Dudick).
 - 4) Semstone 870 Neat (Carboline Company).
 - 5) VE40 with Resin Topcoat (KCC Corrosion Control).

- c. SC3:
 - 1) Core-Cote VEN FF with Resin Topcoat (Sherwin-Williams Company).
 - 2) Flakeline 232 (Ceilcote Corrosion Control).
 - 3) Protecto-Coat 905 (Dudick).
 - 4) Semstone 870AFC with aluminum silicate aggregate (Carboline Company).
 - 5) VE40.2 (KCC Corrosion Control).
 - d. SC4: Not used.
- B. Chemical Resistance: Must not be affected by or cause reaction to the following at 120 degree temperature of product:
- 1. SC1: Ferric Chloride, Sodium Bisulfite, Potassium Permanganate, Sodium Polyphosphate, Alum Slurry, Potassium Monosulfate, Aluminum Sulfate, and Aluminum Chloride.
 - 2. SC2: Hydrofluosilicic Acid - 35 percent; Caustic (Sodium Hydroxide) - 10 percent, Orthophosphate
 - 3. SC3: Sodium Hypochlorite - 17 percent.
 - 4. SC4: Hydrochloric Acid - 37 percent (Muriatic Acid).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions under which coating shall be performed for compliance with requirements for application of coatings. Do not proceed with application until unsatisfactory conditions have been corrected.
- 1. Start of coating Work shall be construed as applicator's acceptance of surfaces within a particular area.

3.02 PREPARATION

- A. Remove hardware, hardware accessories, plates, machined surfaces, light fixtures, and similar items which are not to be coated, or provide surface-applied protection prior to surface preparation and coating. Remove these items if necessary for complete coating of the items and adjacent surfaces. Following completion of coating operations in each space or area, reinstall items removed, using workmen skilled in the trades involved.
- 1. Clean surfaces before applying coatings or surface treatments. Schedule cleaning and coating application so dust and other contaminants will not fall on wet, newly coated surfaces.
- B. Surface Preparation: Perform surface preparation and cleaning in compliance with the manufacturer's instructions for the particular substrate conditions and as specified.
- 1. Cementitious Surfaces: Prepare surfaces of concrete, concrete masonry, cement plaster, and similar surfaces to receive special coatings by removing existing coatings, efflorescence, chalk, dust, dirt, release agents, grease, oils, and by roughing if required to remove glaze. If hardeners or sealers have been used to improve concrete curing, use mechanical methods of surface preparation.
 - a. Use abrasive blast cleaning methods if recommended by the coating system manufacturer.
 - b. Determine alkalinity and moisture content of surfaces to be coated by performing appropriate tests. Do not apply coatings over surfaces where moisture content exceeds that permitted in the manufacturer's printed directions.
 - c. Acid-etch of concrete surfaces is not allowed.

- C. Material Preparation: Carefully mix and prepare materials in compliance with the coating manufacturer's directions.
 - 1. Stir materials before application to produce a mixture of uniform density and as required during application. Do not stir film, which may form on surfaces, into the material. Remove film, and if necessary, strain the coating material before using.

3.03 APPLICATION

- A. Apply special coatings by roller, spray, squeegee, or other applicators in accordance with manufacturer's directions. Use brushes best suited for the material being applied. Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
 - 1. Provide finish coats compatible with the primers used.
 - 2. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with manufacturer's directions.
 - 3. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place in areas to be coated. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.
 - a. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces.
- B. Minimum Coating Thickness: Apply each material at not thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.
- C. Prime Coats: Before application of finish coats, apply a prime coat, as recommended by manufacturer, to material required to be coated or finished and which has not been prime coated by others.
 - 1. Recoat primed and sealed substrates where there is evidence of suction spots or unsealed areas in the first coat to assure a finish coat with no burn-through or other defects due to insufficient sealing.
- D. Mechanical Applications: Use mechanical methods for coating application when permitted by the manufacturer's recommendations, governing ordinances, and trade union regulations.
 - 1. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double-back with spray equipment building up film thickness of 2 coats in one pass, unless recommended by the manufacturer.
- E. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or recoat work not in compliance with specified requirements.

3.04 CLEANING

- A. Clean Up: At the end of each workday, remove rubbish, empty cans, rags, and other discarded materials from the Site.
 - 1. Upon completion of Work, clean glass and spattered surfaces. Remove spattered coatings by washing, scraping, or other proper methods using care not to scratch or damage adjacent finished surfaces.

3.05 PROTECTION

- A. Protect work of other trades, whether to be coated or not, against damage from coating. Correct damage by cleaning, repairing, replacing, and recoating as acceptable to ENGINEER. Leave in an undamaged condition.
- B. Provide "Wet Paint" signs to protect newly coated finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of coating operations.
 - 1. At completion of construction activities of other trades, touch-up and restore damaged or defaced coated surfaces.

END OF SECTION

SECTION 10141 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Dimensional characters.
 - a. Fabricated channel dimensional characters.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign.
- C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
- B. Thermal Movements: For exterior dimensional characters, allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 DIMENSIONAL CHARACTERS

- A. Fabricated Channel Characters: Metal face and side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.
 - 1. Character Material: Sheet or plate aluminum
 - 2. Character Height: 16 inches.
 - 3. Character Depth: 2 inches.
 - 4. Finishes:
 - a. Integral Aluminum Finish: Black anodized.
 - 5. Mounting: Manufacturer's standard for size and design of character.

2.03 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. For exterior exposure, furnish stainless steel devices unless otherwise indicated.
 - 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - 4. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.04 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 4. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
 - 1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match building façade color.

PART 3 - EXECUTION

3.01 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

- B. Mounting Methods:
 - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
 - 2. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.

- C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION

SECTION 11131 - LOADING DOCK BUMPERS

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 loading dock bumpers.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of loading dock bumper.
- B. Shop Drawings: For dock bumpers. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.01 LOADING DOCK BUMPERS

- A. General: Surface-mounted bumpers; of type, size, and construction indicated; designed to absorb kinetic energy and minimize damage to loading dock structure.
 - 1. Source Limitations: Obtain from single source from single manufacturer.
- B. Laminated-Tread Loading Dock Bumper: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch-diameter, steel supporting rods that are welded at one end to 1/4-inch-thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch of tread plies extending beyond the face of closure angles.
 - 1. Thickness: 6 inches.
 - 2. Horizontal Style: 10 inches high by 12 inches.
- C. Anchorage Devices: Galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated. Hot-dip galvanized according to ASTM A153/A153M or ASTM F2329/F2329M.
- D. Materials: ASTM A36/A36M for steel plates, shapes, and bars. Hot-dip galvanize according to ASTM A123/A123M.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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Water System

Corrosion Control Improvements

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- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Loading Dock Bumpers: Attach loading dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.
 - 1. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
 - 2. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
 - 3. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.

3.03 ADJUSTING

- A. After completing installation of exposed, factory-finished dock bumpers, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 11243 - CHEMICAL FEED EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for furnishing the fabrication, production, installation, or erection of the items specified in this Section as shown on Drawings or listed on Schedule.
- B. Major Items:
 - 1. Chemical metering pumps
 - 2. Calibration columns.
 - 3. Pressure relief valves.
 - 4. Back pressure/anti siphon valve.
 - 5. Fabricated chemical feed stations.
 - 6. Chemical transfer pumps.
 - 7. Chemical scales.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include the following:
 - 1. Pump data sheets indicating type of pump; chemical service; pump capacity; discharge pressure at scheduled capacity; maximum stroking speed; NPSH required; and electrical data.
 - 2. Pump dimensional drawing.
 - 3. Materials of construction.
 - 4. Motor horsepower.
 - 5. Electric control data.
 - 6. Corrosion resistance data for all materials in contact with pumped fluid.
 - 7. Data for accessories to be supplied.
- B. Start-up and Demonstration: A written report shall be submitted to ENGINEER documenting testing, start-up, and/or inspection results. The report shall be prepared as noted under Section 01650.
- C. Operation and Maintenance Manuals: Submit, in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
- D. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the specified requirements, manufacturers offering projects which may be included in Work include :
1. Flooded Suction Centrifugal Pumps:
 - a. Lutz-Jesco America Corp., Model TMP05.11
 - b. Or Equal.
 2. Mechanical Diaphragm Pumps:
 - a. Grundfos, Model DDA 30-4, DDA 12-10 or DDA 7.5-16 without exception.
 3. Scale:
 - a. Mettler Toledo, without exception.

2.02 EQUIPMENT

- A. Chemical Feed Service :

Design Criteria	Value
Supplier	Carus Corporation
Recommended Product	8700
Total Phosphate as PO ₄	32.0%
Polyphosphate as PO ₄	15%
Orthophosphate as PO ₄	85%
Specific Gravity (at 77° F)	1.34 (+/-0.03)
Density, lb/gal	10.93

1. Chemical feed pumps and appurtenacnes shall be :
 - a. Compatible with the above chemical.
 - b. NSF 60 certified.
- B. Flooded Suction Centrifugal Pumps (Transfer Pumps):
 1. Type:
 - a. Magnetically coupled centrifugal pump.
 - b. Feed Rate Range: See pump schedule
 2. Flooded Suction centrifugal pumps shall be horizontal, flexible-coupled, based-mounted designed for pumping polyphosphate at 40 percent solution from bulk tanks to day tanks.
 3. Casing shall be end suction, top centerline discharge, self-venting, and arranged for back pullout. Casing shall be constructed of glass fiber reinforced polypropylene.
 4. Disassembly of the pump shall not require disturbing either suction or discharge flanged connection. Casing shall be tested with internal hydrostatic pressures of at least 50 psi, and under this testing pressure there shall be no leakage or distortion.
 5. Mechanical seals shall be single seals with silicon carbide mating faces, and FKM O-rings and all titanium metal parts.
 6. Impeller shall be constructed of titanium, balanced statically and dynamically, finished smooth inside and outside and firmly secured to the shaft.
 7. Shaft and Shaft Sleeve: Shaft shall be 316 stainless steel, designed to have less than a 0.002-inch deflection at face of stuffing box under any condition of loading. Shaft sleeve shall be renewable and constructed of titanium.
 8. Body:
 - a. Reinforced thermoplastic polymers.

- b. GFR-PP (glass fibre reinforced polypropylene) or CFF-E-CTFE (EtyleneChloroTrifluoroEtylene carbon fibre filled).
 - 9. Motor:
 - a. NEMA design.
 - b. Enclosure: Totally enclosed, fan cooled.
 - c. Speed: 3,450 rpm.
 - d. Maximum Size: 1 horsepower.
 - e. Voltage: 120 volt, single phase, 60 Hertz.
- C. Mechanical Diaphragm Pumps (Feed Pumps):
 - 1. Type:
 - a. Positive displacement, mechanically actuated, piston drive type
 - b. Feed Rate Range: See pump schedule
 - 2. Chemical metering pump skids shall be completely assembled by the pump supplier and include mechanical diaphragm pumps, piping, valves, instrumentation, controls, accessories, and integral containment as shown on the Drawings. All components provided by the pump supplier shall be arranged within the limits of the containment base. The pumps shall have capacities as specified and shall be adjustable between 0 percent and 100 percent of the rated capacity. The pumps shall be sized to pump the maximum capacities at a discharge pressure indicated on Schedule.
 - 3. Chemical metering pumps shall be skid mounted, table mounted and shall be integrated equipment packages to meter and feed chemicals. Provide two (2) duty pumps on the skid and one (1) stanby pump on the shelf as shown on the Drawings.
 - 4. Pumps shall be suitable for pumping the applicable chemical from storage tanks to points of application.
 - 5. The pumps shall be of single diaphragm construction. Drive mechanism shall be completely enclosed with integral lubrication system. The pumps shall be provided with an exterior relief valve.
 - 6. All wetted parts including valve housing and fittings shall be constructed of Teflon, alumina ceramic, PVC or other materials designed to handle the chemical being pumped.
 - 7. The pump shall be provided with manual mechanical stroke adjustment which has a graduated scale for adjusting the feed rate over at least a 100 to 1 ratio. An automatic control system shall be provided as indicated on Schedule.
 - 8. Plastic splashguards mounted over the head end of the pump shall be provided for each pump.
 - 9. Furnish pressure relief valves, calibration columns, piping, valves, and other appurtenances as indicated on the Drawings and as required for a complete and proper installation.

2.03 CONTROLS AND ACCESSORIES

- A. Controls:
 - 1. Provide discrete and analog status to the SCADA system. Refer to instrumentation drawings for additional information. Those status's include dry contacts for pump running, pump in remote, pump fault. Pump shall accept dry contact output from SCADA for start/stop when in remote operation selectable at each pump. Pump shall accept isolated 4-20MA signal for pump speed control when in remote operation and shall output an isolated 4-20MA signal for pump speed feedback. Controls shall be provided for each pump to allow for local operation including manual start/stop and speed control.
 - 2. The pump supplier shall include the necessary connectors, cords/cables, and associated hardware as required for each pump to connect the power, controls and signals shown on the electrical and instrumentation Drawings. Contractor shall coordinate cable length with pump supplier.

- B. Piping: Piping shall be as specified in Section 15150 Basic Mechanical Requirements.
- C. Isolation Valves: Valves shall be as specified in Section 15115 Plumbing Valves.
 - 1. Valves for chemical service ½-inch and smaller shall be diaphragm valves.
 - 2. Valves for chemical service larger than ½-inch shall be ball valves, unless otherwise shown on Drawings.
- D. Pulsation Dampener: Diaphragm type pulsation dampeners, each with a minimum volume of 10 times the maximum stroke displacement, shall be furnished with each pump as indicated on Drawings. Each pulsation dampener shall be provided with suitable wall brackets or supports so that its weight is not transferred to the connecting piping. The diaphragm shall be of an elastomer, resistant to the pumped fluid. All metal parts in contact with the liquid shall be coated with a fluid resistant plastic or suitable material.
- E. Backpressure Valve: A backpressure valve shall be installed in the discharge piping or be an integral part of each pump. The backpressure valve shall consist of an all PVC body and an elastomer cylinder which is deformed on each pump stroke allowing the fluid to pass through the valve. The elastomer cylinder shall be suitable for the fluid service. The amount of backpressure provided shall be as recommended by pump manufacturer, but shall in all cases be of sufficient backpressure to prevent the fluid from siphoning through the pumps for the installation shown on Drawings. As an alternate, a Teflon diaphragm adjustable spring loaded valve with suitable wetted parts for the fluid handled may be supplied.
- F. Calibration Cylinders: Calibration cylinders shall be provided where indicated on Drawings. Cylinders shall be PVC construction, provided with a vented top and graduations marked in gallons. Calibration chambers shall be sized to provide a minimum pump down time of 1 minute based on operating the associated pump at full pump capacity. In cases where two different sized pumps are connected to the same calibration chamber, the sizing of the chamber shall be based upon the larger pump.
- G. Pressure Transmitter: By Rosemount. Refer to instrumentation Drawings for additional information.
- H. Pump Support Wall Brackets: Pump support wall brackets shall be provided where indicated on Drawings or on Schedule. Wall brackets shall be manufacturer's standard, sized to adequately support pump from wall. Wall brackets located in corrosive areas shall be made from materials resistant to the environment or coated with corrosion-resistant coating as specified in Section 15050.
- I. Scale:
 - 1. Scales shall be provided where indicated on Drawings and as listed in the Scale Schedule.
 - 2. Shall have be equipped with the following :
 - a. Capacity: See scale schedule.
 - b. Size: See scale schedule.
 - c. Enclosure rating: IP68 or NEMA 6P.
 - d. Interface: Analog.
 - e. Cover: Double painted stainless.
 - f. Manufacturer: Mettler-Toledo, LLC, Model PFA584.
 - g. High accuracy of ± 0.1% of capacity
 - h. Standard indicator: 3-1/2 digit LCD display with easy readability to 1 lb. (kg) or 0.1 lb. (kg)
 - i. Provide charts confirming the corrosion-resistant characteristics of the coating to be used.

3. Weighing Terminal:
 - a. Indicator Housing: NEMA 4X.
 - b. Communications: Ethernet.
 - c. Power: 120 VAC, 60 Hz.
 - d. Display: 4.3-inch color TFT.
 - e. Manufacturer: Mettler-Toledo, LLC, Model IND360 Harsh Analog.
- J. Provide, install, and secure a rubber ramp, designed for easy equipment sliding on the scales, with high-quality, durable rubber material.

2.04 SPARE PARTS

1. Flooded Suction Centrifugal Pumps:
 - a. Provide one (1) spare flooded suction centrifugal pump of each size included in the Flooded Suction Centrifugal Pump and Mechanical Diaphragm Pump Schedule.
2. Mechanical Diaphragm Pumps:
 - a. Provide one (1) spare mechanical diaphragm pump of each size included in the Flooded Suction Centrifugal Pump and Mechanical Diaphragm Pump Schedule.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment furnished and installed 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.

3.02 START UP AND TESTING

- A. Start up and testing shall be performed as specified in Section 01650 using Carus 8700 as described in paragraph 2.02.A of this Section.

3.03 FIELD QUALITY CONTROL

- A. Tests: After equipment has been installed, performance tests shall be conducted. The purpose of these tests is to demonstrate that the units have been properly installed, will operate satisfactorily, and meet the specified conditions. These tests shall be conducted in the presence of ENGINEER with the cooperation of manufacturer's representative. The equipment will not be accepted until a satisfactory test has been run.
- B. 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 under in Sections 01600.
- C. Inspection Report: A written report of the installation check shall be submitted to ENGINEER. The report shall be as noted under Section 01600.

11243 - Chemical Feed Pump Schedule

Location	Type ¹	Diaphragm Feed Pump Duty Flow (gph)	No. of Duty Diaphragm Feed Pump	TDH ² (psi)	Options ³
Pump Station No. 1	DD	5	3	30	T
Pump Station No. 3	DD	2	3	30	T
Pump Station No. 4	DD	3	3	30	T
Pump Station No. 8	DD	2	3	30	T
Pump Station No. 9	DD	2	3	30	T
Pump Station No. 11	DD	2	3	100	T
Pump Station No. 12	DD	1	3	30	T
Pump Station No. 14	DD	1	3	30	T
Pump Station No. 22	DD	2	3	30	T
Pump Station No. 24	DD	5	3	30	T
Pump Station No. 25	DD	3	3	30	T
Pump Station No. 39	DD	2	3	150	T

Notes:

1. DD = Duplex Diaphragm Feed Pump, SD = Simplex Diaphragm Feed Pump

2. TDH = Total Dynamic Head. Discharge pressure is approximate. Coordinate discharge pressure with pump supplier and back pressure valve selection/pressure setting.

3. F = Floor mounted diaphragm feed pump skid, T = Table mounted pump skid.

11243 - Chemical Transfer Pump Schedule

Location	Type ¹	Centrifugal Transfer Pump Duty Flow (gpm)	No. of Centrifugal Transfer Pump Duty + 1 Standby	TDH ² (psi)	Options ³
Pump Station No. 1	CT	14	2	15	F
Pump Station No. 3	CT	7	2	15	F
Pump Station No. 4	CT	7	2	15	F
Pump Station No. 9	CT	7	2	15	F
Pump Station No. 11	CT	7	2	15	F
Pump Station No. 12	CT	7	2	15	F
Pump Station No. 14	CT	7	2	15	F
Pump Station No. 22	CT	7	2	15	F
Pump Station No. 24	CT	7	2	15	F
Pump Station No. 25	CT	7	2	15	F
Pump Station No. 39	CT	7	2	15	F

Notes:

1. CT = Centrifugal Transfer Pump.
2. TDH = Total Dynamic Head. Discharge pressure is approximate. Coordinate discharge pressure with pump supplier and back pressure valve selection/pressure setting.
3. F = Floor mounted diaphragm feed pump skid, W = wall mounted diaphragm feed pump skid.

**11243 - Chemical Feed Equipment
Scale Schedule**

Location	Footprint (in)	Minimum Load Capacity (lbs)	Load Capacity (lbs)
Pump Station No. 1	48x48	50	1,500
Pump Station No. 3	48x48	50	1,000
Pump Station No. 4	48x48	50	1,000
Pump Station No. 8	60x60	50	1,000
Pump Station No. 9	48x48	50	5,000
Pump Station No. 11	48x48	50	1,000
Pump Station No. 12	48x48	50	1,000
Pump Station No. 14	48x48	50	1,000
Pump Station No. 22	48x48	50	1,000
Pump Station No. 24	48x48	50	1,000
Pump Station No. 25	48x48	50	1,000
Pump Station No. 39	48x48	50	1,000

END OF SECTION

SECTION 13122 – PRE-ENGINEERED FIBERGLASS SHELTERS

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: Extent of pre-engineered fiberglass shelters as shown on Drawings, including pre-engineered shelter, and required electrical wiring, devices, heating and ventilation equipment.
- B. Related Sections:
 - 1. Section 03300 "Cast-in-Place Concrete" for installing anchor bolts.

1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Factory-fabricated, pre-engineered shelter FRP building assembly, components, and anchorage by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Fiberglass buildings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7-10 and the structural design criteria set forth in the general notes on structural plans:
 - 1. Snow Loads: 30 PSF.
 - 2. Wind Loads: 120 MPH
 - 3. Mechanical loads supported from structure.
 - 4. 250 lbs roof point load.
 - 5. Seismic Zone: Zone 2.
- C. Building shall be completely waterproof, air and watertight, corrosion and chemical resistant and environmentally aesthetic.
- D. Average R-value of assembled building shall be minimum of R-7.

1.04 REFERENCES

- A. ASTM C 518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM D 256 – Standard Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.
- C. ASTM D 618 – Standard Practice for Conditioning Plastics for Testing.
- D. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.

- E. ASTM D 732 – Standard Test Method for Shear Strength Plastics by Punch Tool.
- F. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- G. ASTM D 792 – Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
- H. ASTM D 1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.
- I. ASTM D 2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
- J. Unless otherwise noted, all specifications and references are made to current edition of the publications.

1.05 SYSTEM DESCRIPTION

- A. Provide one (1) factory pre-molded construction FRP shelter of the each following sizes:
 - 1. Size: Pump Station 8 - 14' W x 18' D x 12' H outside dimensions as shown on the Drawings.
 - 2. Size: Pump Station 12 - 16' W x 18' D x 12' H outside dimensions as shown on the Drawings.
 - 3. Size: Pump Station 14 - 14' W x 18' D x 12' H outside dimensions as shown on the Drawings.
 - 4. Size: Pump Station 22 - 16' W x 18' D x 12' H outside dimensions as shown on the Drawings.

1.06 QUALITY ASSURANCE

- A. Building shall be end product of one manufacturer.
- B. Manufacturer shall have a minimum of 10 years' experience fabricating and erecting similarly sized
- C. Pre-installation Conference: Verify that the concrete slab is level, true to plane, and of the correct dimensions to receive the pre-engineered FRP shelter. Correct all deficiencies before proceeding
- D. Use only qualified workers trained to handle and erect pre-engineered FRP shelters.

1.07 SOURCE QUALITY CONTROL

- A. The manufacturer shall maintain a continuous quality control program and upon request shall furnish to the engineer certified test results of the physical properties.

1.08 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01300, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Certified independent test results of representative wall laminate.
 - 2. Submit Shop Drawings showing:
 - a. Critical dimensions, jointing, and connections, fasteners, and anchors.
 - b. Materials of construction.
 - c. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.
 - d. Color.

3. Calculations: Structural design calculations, sealed by an independent licensed Professional Engineer in the state of Michigan.
- B. Samples: 8-inch square sample of representative wall construction, upon request.
- C. Manufacturer's installation instructions.

1.09 WARRANTY

- A. Shelters shall be warranted to be free of defects in workmanship and materials for a period of two (2) years from substantial completion.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Building shall be shipped as one assembled unit after factory assembly.
- B. All equipment shall be delivered in good, sound condition, and free from damage. Equipment which has been damaged will be rejected.
- C. The Contractor shall be responsible for proper unloading, handling, and storage of equipment in accordance with the Manufacturer's instructions.
- D. Manufacturer shall provide lifting eyes, gasket for slab mounting, and door spacers to be used in moving and positioning the shelter for installation.
- E. Store and protect at manufacturer's site prior to shipment. Structure shall be reinforced and shrink wrapped prior to shipment to prevent warping or fracturing during shipping. Manufacturer is responsible that structure is not damaged during shipping. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

1.10 COORDINATION

- A. CONTRACTOR to coordinate installation of anchors for fiberglass building with manufacturer. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include, but are not limited to, the following:
 1. Tracom, Inc.
 2. Jacobs Manufacturing
 3. Warminster Fiberglass

- B. Requests for substitution must be made in writing and received by the engineer's office a minimum of ten (10) business days before bid opening. Substitutions shall be made in accordance with the provisions of Section 01600.
- C. Substitutions: Manufacturers not pre-approved shall not be allowed.

2.02 LAMINATE MATERIALS

- A. Resins:
 - 1. Resins shall be orthophthalic polyesters. Fillers and additives may be used to achieve chemical resistance and fire retardant properties specified.
 - 2. Resins shall be suitable for service in temperature range from -30°F to +140°F.
- B. Gel Coat: Isophthalic NPG, UV inhibitor, chalk resistant, color per OWNER's selection.
- C. Glass Reinforcing: Glass fiber reinforcement shall be Type E glass and shall be treated with a finish compatible to the resin being used. The glass fiber reinforcement shall be of the following compositions:
 - 1. Chopped Roving: Glass fiber roving manufactured by PPG, Owens Corning, or equal and shall be used for the purposes of making random fibers 1 1/4" in length.
 - 2. Stitch Mat: Type CM-2415 or CDM-2415 manufactured by BTI, Knytex, or equal.
- D. Insulation shall be minimum 1-in. thick ridged polyisocyanurate urethane foam system designed for permanent thermal insulation properties at temperature ranges of -300 to +300 degrees F.
- E. Fiberglass Reinforced Plastic (FRP) Composition:
- F. Building Panels: Wall and roof panels shall be high gloss molded of the following composition:
 - 1. A combination of two (2), minimum 1/8-in. thick, skins consisting of 18 mils minimum isophthalic NPG exterior gel coat, minimum 1 1/4-in. random fiber - chopped roving (minimum glass content to be 35% by weight), and polyester structural laminating resin sandwiching a solid polyisocyanurate urethane insulation core molded to the desired structural and architectural shape.
 - 2. Panel Flanges: Minimum 1/4-in. FRP laminate or stainless steel.
 - 3. Perimeter Anchoring Flanges: The anchoring flanges shall be minimum 1/4-in. thick FRP laminates or stainless steel. In addition one layer of stitch mat shall be used. The stitch mat shall be laminated within the anchoring flange.
 - 4. Physical Properties: Fiberglass reinforced plastic shall have a minimum Barcol Hardness of 35.
 - 5. Mechanical Properties: Fiberglass reinforced plastic shall have the following properties:
 - a. For laminates with stitch mat and random chopped fibers warp direction:

	Strength (psi)	Modulus (msi)
Minimum tensile properties	61,400	2.98
Minimum compressive properties	44,500	2.28
Minimum flexural properties	73,700	2.35

- b. For laminates with random chopped fibers only:

	Strength (psi)	Modulus (msi)
Minimum tensile properties	12,500	1.10
Minimum compressive properties	22,700	1.04
Minimum flexural properties	23,800	0.97

2.03 MISCELLANEOUS MATERIALS

- A. Concrete Anchors: Anchor bolts shall be minimum 1/2-in. diameter 316 stainless steel conforming to requirements of Section 03250, with oversized stainless steel plate washers to prevent localized stressing of the base flange.
- B. Metals: Any structural steel used on composite FRP structure shall 316 stainless steel.
- C. Doors: (Grade I - Premium) Fiberglass Reinforced Plastic Doors – Single Panel 4068.
 - 1. Face Panels: Standard face panels shall be chemical resistant, using a fiberglass-reinforced polyester resin system with light stabilizing additives. Thickness of panels shall be 0.090 to 0.125, with a standard of 0.120”.
 - 2. Door width: See plans for door widths for each building.
 - 3. Door Thickness: 1-3/4”.
 - 4. Finish: All surfaces shall have a textured, semi-gloss, seamless gel coat finish. Gel Coat coverage shall be 15 mil thick, plus or minus 3 mils.
 - 5. Color: As selected by ENGINEER to match building exterior.
 - 6. Internal Construction:
 - a. Stiles and Rails shall be constructed of rectangular and square high modulus pultruded fiberglass tubes.
 - b. Core material: Polyurethane Foam Core, 1 1/2” thick rigid block of polyurethane with an “R” factor of 11-12 shall be laminated to the interior of the face panels.
 - c. Internal reinforcements for full mortise hinges to be solid F.R.P. blocking and for thru-bolted hardware to be high modulus pultrusions.
 - 7. Fiberglass Reinforced Plastic Frames
 - a. Head and Jamb: Pultruded fiberglass reinforced plastic, minimum 1/4” wall thickness, conforming to SDI requirements.
 - b. Frame Profile: Double rabbeted with 5/8” stop. Face will be 2” with a standard jamb depth of 5 3/4”.
 - c. Joint Connection: Jamb to Head joints will be neatly mitered at 45 degrees.
 - d. Finish: 15 mil +/- 3 mil gel coat finish. Color to match door unless otherwise indicated.
 - e. Reinforcements: Corner reinforcement at frame corner will be pultruded fiberglass angle, 4” x 4” x 5 3/8” x 1/4”.
 - 8. Hardware: All hardware and fasteners to be highest grade corrosion resistant available.
 - a. Hinges, 4 1/2” x 4 1/2” NRP triple butt style in Type 316 stainless steel.
 - b. Lockset, Sargent, entrance function.
 - c. Threshold, solid F.R.P., 1/2” beveled profile.
 - d. 20” x 24” insulated window.
 - e. Weatherstrip and sweep, full perimeter sealing.
 - f. Closer

- D. Internal Mounting Flange: 3 inches wide x 1/4 inch thick (minimum) with closed cell neoprene sponge rubber gasket 2 inches wide x 3/8 inch thick to provide a weather-tight seal around the building perimeter.

2.04 BUILDING HVAC

- A. Corrosion Resistant Fan: Shutter-mounted exhaust fan with integral fiberglass gravity shutter, fiberglass reinforced polypropylene fan blades, fiberglass canopy, and epoxy coated wire guard.
 - 1. The fan shall have a capacity of 524 CFM.
- B. Shutter: Motor operated fiberglass intake shutter, with heavy duty fiberglass frame and exterior removable T-316 stainless steel insect screen.
 - 1. The shutter shall be 18 inches by 18 inches.
 - 2. A Fiberglass hood shall be provided over the intake shutter.
- C. Min. (1) 4000-watt electrical heater per building. Heaters shall be sized to maintain building temperature of 55°F with ventilation at full rate with an outdoor temperature of -10° F. The heater shall be able to maintain delta 80 with temps of -20 to 60 deg F. Heaters shall be have corrosion resistant coating suited for atmosphere with orthophosphate chemical stored. Coatings on heating surfaces such as heresite or electro-fin coating and industrial epoxy coating on remainder of the unit. Heaters shall be configured with for 120/208V power supply.

2.05 BUILDING ELECTRICAL

- A. Electrical
 - 1. Circuit Breaker Panel: 120 / 208 VAC, 1 phase, surface mount, 125 amp, main lug, 8 branch, NEMA 4X enclosure.
 - 2. Electrical Wiring: 12 gauge stranded, color-coded THHN/THWN/MTW electrical wiring in rigid, U.L. listed, corrosion / impact resistant, non-conductive, Schedule 40 PVC conduit. SO cord or other non-encased wiring shall not be acceptable. See electrical drawings for electrical wiring to be provided
 - 3. Receptacle: GFCI receptacle 15A 125V, 20 A 125V feed-through, with 5mA +/- 1mA trip threshold shall be provided inside the building per electrical drawings.
 - 4. A switch with weatherproof switch box, single toggle, for light / fan shall be provided per electrical drawings.
- B. Lighting
 - 1. Interior Light: Lamp shall be wired to the weatherproof light / fan switch.
 - a. Provide 100 watt, vapor-tight LED light. Refer to electrical drawings for lights, outlets and wiring to be provided.
- C. Refer to electrical drawings for lights, outlets and wiring to be provided.

2.06 EQUIPMENT MOUNTING ACCESSORIES

- A. Manufacturer shall provide pre-installed unistrut supports for mounting process components, electrical conduit, wiring, lighting, and controls as indicated in the plans. FRP unistrut supports shall be anchored to building walls at 16" on center. They shall extend from floor to ceiling height. These supports shall be adequate to support all piping, conduit, and disconnects.
- B. Mounting Panel
 - 1. Mounting panels shall be provided by the building manufacture to accommodate the process, electrical and instrumentation components shown on the drawings.

2.07 FABRICATION

- A. Form individual segments on high gloss molds ensuring consistent dimensions of finished parts. Cast each segment in one piece.
- B. Laminate shall consist of alternating layers of stitch mat and/or chopped roving impregnated with resin.
- C. Panel flanges and perimeter anchoring flanges shall be formed to the interior of the building.
- D. Insulation shall be bonded to the interior and exterior laminate with resin.
- E. Loss of bond between insulation and laminate may cause reduction in panel strength and, therefore, is cause for rejection.
- F. The interior finish shall be white corrosion resistant FRP.
- G. The exterior finish shall be high gloss molded gel coat, color to be coordinated with the OWNER .

2.08 ASSEMBLY

- A. Shop assemble complete building.
- B. Seal exterior edges of adjacent panels with color matched silicon sealant.
- C. Fit and bond appurtenances, formed separately, into openings cut in finished panel or integrally mold into panel. Bond attachments with glass fibers and resin from interior of panel.
- D. Resin seal all cut and drilled edges.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Substrates, areas, and conditions shall be inspected with Installer and Engineer for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Seal exterior edges of adjacent panels with color matched silicon sealant.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Resin seal all cut and drilled edges.

3.02 INSTALLATION

- A. Install products in accordance with the Drawings, Specification, and local codes, and in a manner consistent with the manufacturer's installation instructions and recommendations.
- B. Verify door operation and set all anchor bolts prior to removing the door spacers provided during shipment of the shelter.
- C. Move and position the shelter using the lifting eyes provided. Position the provided neoprene gasket between the concrete slab and the building mounting flange. If more than one lifting eye is provided, use a spreader bar.
- D. After closing the shelter doors:
 - 1. Layout the anchor bolt pattern. The anchor bolts should be installed in accordance with the engineer's instructions.
 - 2. Drill and set the anchor bolts starting with one on each side of the doors. The anchor bolts behind and in front of the doors should be flat head anchors if the mounting flange is external.
 - 3. Drill the anchor bolt holes to the depth and diameter required by the anchor bolt manufacturer. Stainless steel wedge style concrete anchors [1/2 inch diameter x 4-1/2 inches long – (minimum)] are recommended. Anchor bolts are to be supplied by Contractor.
 - 4. Verify the operation of the doors before installing the remaining anchor bolts.
 - a. Failure to verify the operation of the doors before the remaining anchor bolts are set may result in the binding of the door against the door frame.
 - 5. Install the threshold (if supplied) and re-verify the operation of the doors.
 - 6. After all anchor bolts have been completely set, remove the door spacers.
- E. Seal the flange with sealant or grout to ensure watertightness.
- F. Install (as necessary) and test the shelter accessories in accordance with the manufacturers' instructions.
- G. For additional installation instructions refer to latest revision of document OPS-I.

3.02 ADJUST AND CLEAN

- A. Adjust doors and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.
- C. After completing installation, inspect exposed finishes and repair damaged finishes.
- D. Adjust fan speed to obtain the flow rates indicated in this specification. Coordinate testing and balancing.
- E. Clean surfaces in accordance with the manufacturer's instructions.
- F. Remove trash and debris and leave the site in a clean condition.

END OF SECTION

SECTION 13205 - CHEMICAL STORAGE TANKS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, construction equipment, and miscellaneous services necessary for the construction and installation of chemical storage tanks and their accessories as shown on Drawings and specified below.
- B. Chemical storage tanks furnished under this Section shall include the following:
 - 1. Cross-linked HDPE Double Wall Containment Tanks.

1.02 REFERENCES

- A. Reference Standards:
 - 1. ANSI Class 150.
 - 2. ASME Code.
 - 3. ASTM D 3299.
 - 4. ASTM D 3486.
 - 5. ASTM D 638
 - 6. ASTM D 883
 - 7. ASTM D 1505
 - 8. ASTM D 1693
 - 9. ASTM F 412
 - 10. ANSI B-16.5
 - 11. Building Code: International Building Code, IBC 2018 / 2021
 - 12. ARM: Low Temperature Impact Resistance (Falling Dart Test Procedure)
 - 13. NSF/ANSI Standard 61, AWWA – Drinking Water System Components
 - 14. ASTM D-1998, Standard Specification for Polyethylene Upright Storage Tanks

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section, including.
 - 1. Manufacturer's installation instructions. Installation instructions shall include requirements for tank mounting surface preparation to prevent failure after tank is placed in service. Instructions shall also include manufacturer's recommendations covering proper handling, lifting, setting, anchoring, and other requirements necessary for proper tank installation and use.
 - 2. Corrosion charts indicating compatibility of chemical with tank resins supplied.
 - 3. Complete drawings, details, and specifications covering the storage tanks, accessories and supports shall be submitted in accordance with Section 01330: Submittal Procedures.
 - 4. The data shall include full information on basic materials and test data confirming the chemical resistance of the proposed resins to the intended tank contents.
 - 5. The data shall also indicate the sizes of all major tank components including tank diameter, wall thickness, overall length, nozzle details and locations, supports and brackets, anchor bolt locations and details, and full information and details concerning field assembly and installation.
 - 6. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Include complete resin system information.

7. Detailed fabrication drawings.
 8. Complete design calculations for tanks, supports, and appropriate accessories.
 9. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
 10. Recommended bolt torques for all bolted connections.
 11. Certified test data on representative samples of standard laminate materials which verify that their physical properties meet the requirements and service conditions specified. Include verification of structural design parameters.
 12. Complete catalog information, descriptive literature, specifications, and materials of construction for tank heating panels, temperature controllers, and other components of the tank heating system.
 13. Final Configuration of Tank Appurtenances: The final locations of tank appurtenances including, but not limited to, nozzles, manways, pipe supports, anchor lugs, pipe connections will be confirmed by the Owner during review of Contractor's drawing submittals.
- B. Test and Inspection Report: Submit in accordance with Section 01600, a written report to ENGINEER documenting testing and inspection results.
- C. The tanks shall meet the requirements of NSF Standard 61 for chemical storage vessels that contain liquids that will be added to potable water.
- D. Operation and Maintenance Manuals: Submit in accordance with Section 01600, operation and maintenance manuals for accessory items included under this Section.
- E. Warranties: Submit in accordance with Section 01770, warranties covering the items included under this Section.

1.04 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 five years.

1.05 WARRANTY

- A. Special Warranty: Provide, in accordance with Section 01700, warranties covering the items included under this Section of the Contract. The special warranty shall repair or replace defective components that fail in materials or workmanship within special warranty period.
1. Warranty Period: Two 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. Cross-linked HDPE Double Wall Containment Tanks:
 - a. PolyProcessing Safe-Tank.
 - b. Or approved equal.

2.02 MANUFACTURED UNITS

A. Not used.

2.03 CROSS-LINKED HDPE DOUBLE WALL CONTAINMENT TANKS

A. Chemical Feed Service :

Design Criteria	Value
Supplier	Carus Corporation
Recommended Product	8700
Total Phosphate as PO ₄	32.0%
Polyphosphate as PO ₄	15%
Orthophosphate as PO ₄	85%
Specific Gravity (at 77° F)	1.34 (+/-0.03)
Density, lb/gal	10.93

B. Tanks shall be constructed of translucent, heavy-duty, double wall, cross-linked polyethylene material. Tank fittings shall be of the bulkhead type as listed in the Accessories paragraph. Contractor shall coordinate fitting locations, sizes, and types with the tank supplier. .

C. Tanks shall be provided with capacities and accessories as indicated on Drawings and as called for in the Specifications.

2.04 ACCESSORIES

A. Tank accessories shall be furnished and installed as noted on Tank Schedule and as detailed or noted on Drawings.

B. Anchoring: Lifting lugs, hold-down lugs, anchor bolts and support saddles shall be furnished according to manufacturer’s recommendations.

C. Manhole Openings:

1. Manhole openings on the top of the tank shall be 24-inch minimum diameter with an integral pressure relief cover or hinged cover to open on any internal pressure buildup to protect against over-pressurization of the tank.

D. Connections:

1. Piping connections and piping support brackets shall be of the size and location as detailed or noted on Drawings and as noted on Tank Schedule.
2. Tank shall be provided with a Sight Guage (transparent sight tube with graduated markings, in gallons, for level indication, as noted on the Tank Schedule. The sight gauge shall be made using 2-inch threaded PVC fittings, true-union ball valves, and clear Schedule 40 PVC pipe. Mounted on the tank adjacent to the sight gauge shall be a gauge board of corrosion-resistant construction calibrated with corrosion-resistant marking in 100-gallon increments. Sight gauge shall be contained in a 4” clear containment pipe as shown on drawings.
3. Tank shall be provided with top-mounted 8-inch-diameter flanged and gusseted nozzle for connection to electrical level transmitter, as noted on the Tank Schedule.
4. Unless otherwise noted on the Drawings or Tank Schedule for Bulk and Day Tanks, the following piping connections shall be standard for all tanks:

- a. One 6-inch flanged and gusseted nozzle, top-mounted, with FRP blind flange cover, tapped for 2-inch fill line.
- b. Tank manufacturer shall also provide internal piping supports as required to securely stabilize the piping.
- c. One 2-inch-diameter flanged and gusseted, full bottom drain.
- d. One 2-inch-diameter flanged and gusseted suction nozzle, mounted 6 inches up from tank bottom.
- e. One 3-inch-diameter flanged and gusseted vent nozzle mounted on top of tank.
- f. One 2-inch-diameter flanged and gusseted overflow nozzle mounted 6 inches from top of tank along straight shell.
- g. All fittings on the bottom 1/3 of the tank sidewall shall have a flexible expansion joint between the tank and connecting piping.
- h. Gaskets shall be compatible with the chemical being conveyed.
- i. Bolts, washers and nuts shall be 316 stainless steel.
- j. Flanged Nozzles :
 - 1) Nozzles for connecting piping and accessories shall be provided on each tank at the locations and of the sizes indicated on the drawings or specified herein.
 - 2) Each nozzle shall be flanged, with flange diameter and drilling conforming to ANSI B16.5, Class 150. Nozzles shall extend at least 4 inches from outside face of tank to face of flange.
 - 3) The level gauge mounting flange shall be above the maximum liquid level recommended by the level sensor manufacturer. The length of the nozzle shall be as recommended by the level sensor manufacturer. The center line of the nozzle shall be at least 24 inches from the tank sidewall, fill nozzle, and other obstructions.
 - 4) Flanged nozzles shall be fabricated of the same material as the tank and shall be gusseted to the tank or otherwise reinforced in accordance with the governing standard.
 - 5) Overflow and Drains: Each tank shall be provided with an overflow and drain line of the size recommended by the manufacturer to provide means for draining the tank and to prevent spills in the event of an overflow. Tank manufacturer shall provide pipe support brackets for the pipe inside the tank.
 - 6) Vents: The tanks shall be provided with a vent as shown on the Drawings to prevent drawing a vacuum inside the tank during pumping or draining. Outside the vent shall be equipped with an insect screen of material compatible with the chemical stored.
- k. Nameplates: Each tank shall be provided with a nameplate to identify the use of the tank. The nameplates shall be of orange phenolic material with black engraved lettering one inch high and shall be mounted on the tank at a location acceptable to the Owner.
- l. Certification Plates: A certification nameplate shall be installed below each storage tank nameplate . Certification plate shall be stainless steel for all services except for sodium hypochlorite and fluoride. Hastelloy-C nameplates shall be used in sodium hypochlorite and fluoride services. The following data shall be included on the certification plate:
 - 1) Name of tank fabricator.
 - 2) Date of manufacture.
 - 3) Product to be stored
 - 4) Maximum allowable concentration, specific gravity and temperature of the specified chemical solution that can be stored safely.
 - 5) Mechanical properties of the laminate.
 - 6) Resin designation.

- m. Pipe Supports: Provide pre-molded clips or strut for the attachment of pipe supports for support of vertical runs of piping from the outside of the tank in the locations shown on the drawings. All pipe supports shall be FRP construction.
- E. Fabrication
- 1. For orthophosphate chemicals, tank resin shall include an antioxidant polyethylene system (OR-1000) with four times the antioxidant properties of a standard polyethylene bonded to the interior surface during the manufacturing process.
 - 2. Wall thickness for a given hoop stress is to be calculated in accordance with ASTM D 1998. In NO case shall the tank thickness be less than design requirements per ASTM D 1998.
 - 3. On closed top tanks the top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. In most cases, flat areas shall be provided for attachment of large fittings on the dome of the tank.
 - 4. Tank colors shall be natural (un-pigmented), black (compounded), or as specified by the OWNER with written agreement by the tank manufacturer

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. All tanks must be unloaded, handled and installed in accordance with manufacturer's instructions. Install tanks on 6-inch concrete pad unless otherwise noted. Provide concrete knockouts where required to accommodate full bottom drain.

3.02 FIELD QUALITY CONTROL

- A. Tests: Tanks shall be hydrostatically tested for 24-hours and visually observed for leakage prior to storing chemical. Testing shall be witnessed by ENGINEER.
- B. Installation Check: The manufacturer shall provide the services of a factory-trained representative or by an Installer certified by manufacturer, to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600.
 - 1. Provide letter of confirmation from manufacturer indicating CONTRACTOR installing the tank is certified.

13205 - Chemical Storage Bulk Tank Schedule

Location	Type ¹	Number of Tanks	Minimum Useable Capacity per Tank ^{2,5} (gal)	Recommended Tank Size (gal)	Maximum Diameter ³ (ft)	Accessories / Connections ⁴
Pump Station No. 1	S	2	850	1,000	6.5	ST, LS, MH, OF, DR, V
Pump Station No. 2	S	1	540	750	5	ST, LS, MH, OF, DR, V
Pump Station No. 4	S	1	570	750	5	ST, LS, MH, OF, DR, V
Pump Station No. 8	S/F	1	310	405	4	ST, LS, MH, OF, DR, V
Pump Station No. 9	S	1	910	1,000	6.5	ST, LS, MH, OF, DR, V
Pump Station No. 11	S	1	750	750	5	ST, LS, MH, OF, DR, V
Pump Station No. 12	S	1	440	540	6.5	ST, LS, MH, OF, DR, V
Pump Station No. 14	S	1	420	540	6.5	ST, LS, MH, OF, DR, V
Pump Station No. 22	S	1	690	750	5	ST, LS, MH, OF, DR, V
Pump Station No. 24	S	2	640	750	5	ST, LS, MH, OF, DR, V
Pump Station No. 25	S	1	710	750	5	ST, LS, MH, OF, DR, V
Pump Station No. 39	S	1	570	750	5	ST, LS, MH, OF, DR, V

Notes:

1. S = Storage, D = Day, S/F = Storage/Feed dual purpose.
2. Useable Capacity is calculated as the volume of liquid available between the bottom of the overflow nozzle and the top of the suction nozzle.
3. Maximum diameter or maximum width at narrowest point.
4. ST = Site Tube, LS = Level Sensor outlet, MH = Manhole Opening, OF = Overflow, DR = Drain, V = Vent
5. Bulk Tank Capacity is based on 30-day chemical storage

13205 - Chemical Storage Day Tank Schedule

Location	Type ¹	Minimum Useable Capacity ^{2,5} (gal)	Recommended Tank Size (gal)	Maximum Diameter ³ (ft)	Accessories / Connections ⁵
Pump Station No. 1	D	71	105	3	DR, V
Pump Station No. 3	D	23	55	3	DR, V
Pump Station No. 4	D	24	55	3	DR, V
Pump Station No. 9	D	38	55	3	DR, V
Pump Station No. 11	D	32	55	3	DR, V
Pump Station No. 12	D	18	55	3	DR, V
Pump Station No. 14	D	17	55	3	DR, V
Pump Station No. 22	D	29	55	3	DR, V
Pump Station No. 24	D	53	55	3	DR, V
Pump Station No. 25	D	30	55	3	DR, V
Pump Station No. 39	D	24	55	3	DR, V

Notes:

1. S = Storage, D = Day, S/F = Storage/Feed dual purpose.
2. Useable Capacity is calculated as the volume of liquid available between the bottom of the overflow nozzle and the top of the suction nozzle.
3. Maximum diameter or maximum width at narrowest point.
4. ST = Site Tube, LS = Level Sensor outlet, MH = Manhole Opening, OF = Overflow, DR = Drain, V = Vent
5. Day Tank Capacity is based on 30-hour chemical storage

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.
- 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. 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.
- 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. 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.
- D. 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.
- E. Calibration Equipment and Testing Apparatus: Equipment supplier shall have available test and calibration equipment for factory panel tests, installation, start-up, service contract, and maintenance or troubleshooting purposes.
 - 1. The equipment required for these tests is as follows:
 - a. Two - Digital Multimeters with an accuracy of plus or minus 0.1 percent.
- F. Component Requirements: For the purposes of uniformity and conformance to industry standards, signal transmission modes shall be either electronic 4-20 mA DC or pneumatic 3-15 psi only. 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.
- G. 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.
- H. 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. West Michigan Instrumentation Systems Inc.
- 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 13899 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.
 - a. Project Engineer/Project Manager's name shall be forwarded to CONTRACTOR and ENGINEER within 30 days after receipt of a purchase order by equipment supplier.
 - b. Project Engineer/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project Engineer/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

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 1, 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. Pneumatic instruments shall have an input and output range of 3-15 psig. Units shall require a 20 psi supply. Provide an air set for each pneumatic unit or for each 20 psi manifold. Bubbler air sets, regulators, valves, etc., must be factory assembled on a subplate as specified and detailed.
 - 2. 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. Charts and scales are shown on Drawings. Standard scales shall not be accepted without ENGINEER's approval if it differs from those shown. Ratio station scales and other scales shall be graduated such that major graduations fall on whole numbers (i.e., 1, 2, 3, or 5, 10, 15, etc.) and minor graduations fall on 0.1 or 0.2 intervals (i.e., 1.1, 1.2 or 11, 12, etc.). If two scales are called for on ratio stations, each scale shall be indexed to meet Specification. Drawing of each scale for ratio stations shall be submitted with Shop Drawings for approval.
- H. 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.
- I. 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 white letters engraved on a black 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.
- J. 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.
- K. 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. PLCs, operator interface computers, touch screen computers, and associated control panels shall be tested at the factory prior to shipment to the Site. ENGINEER is to be given 6 weeks notice before the factory test date; ENGINEER will witness the tests. The purpose of factory testing is to verify correct functioning of equipment and conformity to Project requirements before shipment
- B. Once the PLCs, etc., are connected at the equipment supplier's factory, and it has been demonstrated that the equipment properly communicates, the panels shall remain at the supplier's facility for 5 weeks to allow ENGINEER to check out the ENGINEER developed plc software and operator interface software.

- C. Test Procedures:
 - 1. Hardware testing to verify system wiring, layout, workmanship, and appearance. Demonstrate correct function of inputs and outputs using a switch and lamp "mimic board." Perform a PLC load test to verify that outputs can be driven at full load simultaneously.
 - 2. Control logic tests begin with loading ENGINEER-developed ladder logic software. Control logic and sequences shall be tested and verified using a switch and lamp "mimic board."
 - 3. Operator interface integration test builds upon previously completed phases by exercising entire system from the operator interface computer(s).
- D. At completion of tests, system shall remain intact for a period of at least 2 weeks for ENGINEER's use correcting software errors found during the course of test.
- E. Schedule factory test not before 12 weeks after Shop Drawing status of deliverable items under this Section is either N.E.T. or F.A.C.

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 3 times at Site, including once during installation and 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. Third 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. Third trip shall be for duration of two, 8-hour days at OWNER's facility.
- C. Equipment supplier shall provide two, 8-hour days of training for OWNER's personnel in aspects of operation and maintenance such as use of controls, fuse locations, instruction manuals, etc.
1. Training and instructions at the plant shall be given by the Project Engineer assigned to the Project by the equipment supplier or other personnel as approved by ENGINEER.

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

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 (E-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.
- 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 shall be incorporated in Work include:
 - 1. FO Cables:
 - a. Draka Comteq for single-mode applications.
 - 2. FO Connectors and Couplers:
 - a. AMP Netcon.
 - b. AT&T Network Systems.
 - c. Corning.
 - d. Thomas and Betts Corp.
 - 3. FO Patch Panels:
 - a. Panduit.
 - b. Corning Cable Systems

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 di-electric low loss glass type, fiber-optic single mode(G.652-D) graded-index cables with the following operational and construction features:
 - 1. Single-mode Fibers:
 - a. Cable Type shall be as specified on drawings, all di-electric Cable.
 - b. Number of Fibers: 6 minimum or as listed on Drawings(72 strands for backbone)
 - c. Core-Cladding Diameter: 9.2/125 microns or as listed on Drawings.
 - d. Subunit Size: 2.0 mm or as listed on Drawings.
 - e. Maximum Attenuation: Less than 0.5 dB/1,350 nm.

- f. Minimum Bandwidth: Greater than 500 MHz-km.
 - g. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
 - h. 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 style connectors as required or shown on Drawings.

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 FO cable and 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.

- 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. Tests:
 - a. Single-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
 - 2. 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.
 - 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

SECTION 13421 - FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Magnetic flow meter.

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(no or equal):
 - 1. Magnetic Flow Meter:
 - a. ABB Process Master FEP Series
 - b. Yokogawa Admag AWX Series
 - c. Rosemount 8750 Series.

2.02 MAGNETIC FLOW METER

- A. Magnetic flow meters shall be either flanged or flangeless type as indicated. Meters 4 inches or smaller shall be wafer style. Meters 6-inch or larger shall be of flange design.
- B. Meter body shall be Schedule 10, 304 stainless steel or Schedule 40 steel with 150-pound ANSI flange or AWWA Class D flange when ANSI is not an available option. Meters 4 inches or smaller shall be wafer or flangeless style and shall be designed for installation between 150 Class and 300 Class ANSI, DIN, or BS pipe flanges.
 - 1. Wafer or flangeless style meters 4 inches or smaller shall have a ceramic, Teflon, or Tefzel liner and Hastelloy "C" or platinum electrodes as indicated.
 - 2. Meters 6 to 12 inches shall have Teflon or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
 - 3. Meters 14 inches and larger shall have an Elastomer or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
- C. Liner material shall be suitable for the process flow indicated on Drawings.
 - 1. Meters 4 inches or smaller shall be furnished with a Teflon or Tefzel liner. Exception: Ceramic liner shall be furnished for meters 4 inches or smaller used for lime slurry, sludge, and abrasive process flows.
 - 2. Teflon liner shall be furnished for meters 6 to 12 inches.
 - 3. Polyurethane liner shall be furnished for meters 14 inches and larger, or if not indicated otherwise on Drawings or in the Specifications.

- D. Electrodes shall be suitable for the process flow indicated on the drawings and shall be bullet nosed style made of Hastelloy "C." Exception: Platinum electrodes shall be provided for sodium hydroxide or other caustic process applications.
- E. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer. Service personnel of sales representative or of equipment supplier of this Section will not be accepted.
- F. Meter shall be capable of withstanding continuous submergence in up to 30 feet of water without damage. Meters 10 inches or smaller shall be capable of accidental submergence in 30 feet of water for up to 48 hours. Field coil design shall be such that they shall not overheat or otherwise be damaged if flow tube is not totally filled with fluid. Magmeters shall be provided with 2 grounding rings.
- G. Magnetic flow meter signal converter shall consist of solid-state, feedback-type microprocessor circuitry. Operational parameters shall be user configurable locally via an integral push-button arrangement or via a remote intelligent terminal. Appurtenances, including hand-held programmer and/or programming software, shall be provided for local configuration of operational parameters. Converter shall change a low-level flow signal from sensor electrodes into a proportional isolated 4-20 mA DC signal. The converter shall have an extremely high input impedance and not be affected by quadrature noise. The unit shall be capable of accommodating uni-directional or bi-directional flow. Sensing of meter failure shall activate a user-configurable zero or 130 percent output signal and a failure alarm contact closure.
- H. Where indicated on Drawings, a high-frequency digital proportional output shall be provided for use with high-accuracy totalizers. To eliminate errors, the converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure. An automatic empty pipe detector and low-flow cutoff shall be provided as standard.
- I. Magmeter shall be electronically isolated for grounding. Where insulated or nonconductive pipe is used, only orifice plate-type grounding rings will be acceptable. Grounding electrodes which penetrate the liner will not be acceptable.
- J. Unit shall be supplied with an integral or local conduit-mounted flow indicator calibrated in engineering units. Indicator shall be tagged showing design range in units being measured and shall be capable of simultaneously displaying flow rate and totalization with an alphanumeric display.
- K. Zero stability shall be achieved by pulsing the sensing head magnetic field coils with a regulated direct current, first in one direction and then in opposite direction.
- L. Continuous zero stability shall be obtained by signal sampling during the quiescent coil states. There shall be no zero offset or zero adjustments required. The converter shall not require calibration over its expected life under normal use.
- M. Flow meter shall operate within Specifications on 120 volt AC plus 10 percent and 60 hertz plus 5 percent. Power consumption shall not exceed 25 VA for meters 24 inches and smaller, and 50 VA for meters 30 inches or greater.
- N. Input span shall be adjustable between 0-1 and 0-30 feet per second and range adjustment shall be digital. Converter shall include adjustable damping circuitry. Unit shall not be affected by power line aberrations such as those produced by SCR-type motor controllers or other voltage transients.

- O. System accuracy, including primary magnetic flow meter, shall be plus 0.5 percent of rate for maximum flow velocities from 1.33 to 33.33 feet per second, and plus 1 percent of rate for maximum flow velocities from 0.7 to 1.32 feet per second. Repeatability shall be plus 0.1 percent of span. Rangeability shall meet or exceed 30:1 turndown.
- P. The signal converter portion of the magnetic flow meter shall include both a magnetic driver to power the magnetic coils and the signal converter electronics. The converter shall have the ability to be either integrally or remotely mounted as specified. If not specified, converter shall be remotely mounted. It shall be housed in a NEMA 4 enclosure . When remotely mounted, the signal cable shall be provided with the proper length.
- Q. Magmeter manufacturer shall comply with ISO9000 Standards and the meter shall be FM approved. Signal converters shall be interchangeable without effect of meter accuracy or the need for recalibration for all meter sizes. Provide spool-piece for meters sized 12 inches and smaller.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13423 - LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Sonic level transmitter.
 - 2. Flange mounted level sensor.
 - 3. Cord type float switch.
 - 4. Rod type float switch.
 - 5. Submersible level sensor.
 - 6. Radar level transmitter- as called for on drawings(Vega)

1.02 SUBMITTALS

- A. Shop Drawings: Submit 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. Sonic Level Transmitter:
 - a. Siemens
 - 2. Cord Type Float Switch:
 - a. Anchor Scientific, Inc.
 - b. Consolidated Electric Co.
 - 3. Flange-Mounted Level Sensor:
 - a. Rosemount.
 - b. Yokogawa
 - 4. Rod Type Float Switch:
 - a. Delaval-GEMS Sensor Division.
 - b. Delta Controls Corp.
 - c. Magnetrol.
 - d. Sensilevel.
 - e. Square D Co.
 - 5. Submersible Level Sensor:
 - a. KPSI Inc.

2.02 SONIC LEVEL TRANSMITTER

- A. Sonic level device shall be microprocessor-based and include sensing head, control cabinet, and cable between head and control cabinet. (Furnish 2-wire loop powered version if shown on drawings)
- B. Length of cable shall be sufficient for application shown.

- C. Sensor shall automatically compensate for ambient temperature changes.
- D. CONTRACTOR, equipment supplier, and manufacturer shall examine Drawings for each installation to determine equipment supplied will work in each application.
- E. Drawings shall contain a typical installation detail and show location of sensors.
- F. Equipment supplier must ensure beam angle of sensor shall not have interference from walls, pipes, or other objects at each location. Shop Drawings shall be specific about model numbers at each location, and detail sketches showing mounting height, zero dimensions, span dimensions, and beam angle data for each location.
- G. Any device that will not function reliably to specifications in its application shall be replaced at CONTRACTOR's expense.
- H. Sonic sensor head shall be intrinsically safe for NEMA 7 areas (explosion-proof). Sensor head shall be epoxy-coated metal, encapsulated or mylar for corrosion resistance. Sensor head and reflector shall contain a thermostatically controlled heater for outdoor application for manufacturers that require sensor head heater for operation down to -20 degrees F.
- I. Sonic frequency shall be less than 45 kHz. Frequencies above this range will not be accepted.
- J. Control cabinet shall be supplied rated NEMA 4 or as shown on Drawings. Control cabinet shall contain a receiver processor, a full-hinged front door, a control cabinet thermostat controlled heater for -20 degrees F operation, and local digital indicator configured in engineering units.
- K. Connections to controller and sonic sensor shall be with well-marked terminal blocks.
- L. Field adjustments shall be made through membrane keypads. Units requiring the use of an oscilloscope will not be accepted.
- M. Operational Data:
 1. Temperature: Sensor to operate within specifications over -20 degrees F to 150 degrees F. Controller shall operate from 32 degrees F to 120 degrees F without heater, and -20 degrees F with a heater.
 2. Pulse Rate: 1.5 pps minimum sensing rate.
 3. Operating Frequency: Less than 45 kHz.
 4. Reflection Blocking: Adjustable receiver blanking to operate only on first pulse received.
 5. Cable Length: Sensor and controller may be separated up to 500 feet.
 6. AGC: Automatic gain control to maximize signal to noise ratio.
 7. System Accuracy: Plus or minus 1.0 percent of full scale over the complete temperature range.
 8. Power Supply: 120 volt AC plus or minus 10 percent at 60 hertz with power consumption of 100 watts maximum exclusive of controller heaters.
 9. Output: 4-20 mA output linear with level into 0-700 ohms. Output shall be isolated, floating to prevent system ground loops when used with other control loops that have an established common at a remote location. Output time constant shall be adjustable through keypad from 1 to 10 seconds.

2.03 FLANGE-MOUNTED LEVEL SENSOR

- A. Flange-mounted level sensors shall be pressure to current signal converters and shall be 2-wire, solid-state electronic, temperature-compensated strain gauge or capacitive type, designed for mounting directly on ANSI 150-pound 3-inch flange without diaphragm extension. 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 cast aluminum explosion-proof housing. Transmitter shall output an isolated 4-20 mA signal proportional to pressure measurement. Adjustable electronic damping shall be provided from 0-16 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 six months. Zero suppression and elevation shall be at least 500 percent of range.
- D. Units shall be supplied with an integral digital indicator calibrated 0-100 percent. Provide hand-held configurator.

2.04 FLOAT SWITCH (CORD TYPE)

- A. Direct acting float switch shall be furnished to automatically detect liquid level change. Liquid rise of 1 inch from rest position shall operate float switch and reset will occur when liquid level drops 1 inch. Mounting shall be to a 1-inch vertical pipe for multiple float applications or to a flange for a single float application as shown. Free cable hanging floats with weights shall not be acceptable.
- B. Float switch shall consist of 316 type stainless steel housing, mounting clamp for 1-inch-diameter pipe, flexible 3-conductor cable with a synthetic rubber jacket, and mercury free switch. Inside float housing will be a (normally open/closed) mercury free switch potted in epoxy. Electrical load for switch contacts shall be rated 115 volt AC at 0.5 horsepower inductive load.
- C. Three-conductor cable shall be 14 AWG with 105 strands per conductor made for heavy flexing service and underwater use. A green grounding wire shall connect internally to float housing.
- D. Provide mercury free float switches with molded ABS housing and Form C contact switch. CONTRACTOR shall ensure ampere rating is suitable for load shown on Drawing.

2.05 FLOAT SWITCH (ROD TYPE)

- A. Vertical flange-mounted types shall be caged and provided with an ANSI 150-pound cast iron flange. Contact output shall be SPDT rated at 10 amp.

2.06 SUBMERSIBLE LEVEL SENSOR

- A. Submersible level sensor 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 unit from sensor location.

- B. An electronic control unit shall be provided for transducer. Control unit shall provide proper power source for transducer as well as conditioning circuits for converting the output signal into a useful format. Unit shall have zero and span adjustments. Output from control unit shall be 4-20 mA DC into 500 ohms, and 4 amp rated relay contacts. Adjustable set points and an LED status indicator shall be provided for each output relay.
- C. Control unit shall be housed in a NEMA 4 enclosure and shall operate on 120 volt AC, plus or minus 10 percent, 60 Hertz power. The unit shall contain a LCD digital indicator. 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 BASIS INSTRUMENTATION REQUIREMENTS.

END OF SECTION

SECTION 13424 - PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Pressure seals.
 - 2. Diaphragm seals.
 - 3. 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. Pressure Seals:
 - a. Ashcroft.
 - b. OPW (Ronningen-Petter).
 - c. REO TEMP
 - 2. Diaphragm Seals:
 - a. Ashcroft.
 - b. ITT Conoflow.
 - 3. Pressure to Current:
 - a. Rosemount 3051 series.
 - b. Yokogawa EJA series

2.02 PRESSURE SEALS

- A. Pressure seals shall be of the isolation ring type.
- B. The seal construction shall consist of a body, 360-degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive sensing liquid and 2 assembly flanges. The Iso-Ring ID shall match the pipeline ID. The Iso-Ring OD shall not exceed the ID of the piping flange bolt circle. Units shall be designed to fit 125-pound, 150-pound, and 300-pound ANSI piping flanges, as shown on Drawings.
- C. When not shown, this information shall be obtained by CONTRACTOR from ENGINEER.
- D. The process liquid pressure is transmitted through the flexible cylinder wall and the captive sensing liquid to the pressure seal.

- E. The seal body shall be carbon steel unless otherwise required. Two assembly flanges are carbon steel or 316SS. Flexible elastomeric cylinder is Buna-N or natural rubber. Captive sensing liquid is 50 percent ethylene glycol and water mix or silicone (specify one).
- F. Seal weight in pounds not to exceed four times the nominal pipe size in inches.
- G. Installation: Centering gauges shall be provided to align the ID of the isolation ring with the ID of the process pipeline, holding the ring in place during installation.

2.03 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.

2.04 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 cast aluminum explosion-proof 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. Provide hand-held configurator.

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

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Control panels and consoles.
 2. Switches, push-buttons, lights.
 3. Relays.
 4. Intrinsically safe isolator relays.
 5. Timing devices.
 6. Terminal blocks.
 7. Control power transformers.

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. Allen-Bradley (Type 800MR).
 - b. American Solenoid Company.
 - c. Arrow Hart (Type OB).
 - d. Electroswitch.
 - e. Microswitch (Series PW).
 2. Relays:
 - a. Potter-Brumfield (Type KUP).
 - b. Schrack North America, Inc. (Type CAD).
 - c. Square D Co. (Type KU).
 - d. Rockwell.
 3. Intrinsically Safe Isolator Relay:
 - a. B/W Controls, Inc.
 - b. MTL, Inc.
 - c. R. Stahl, Inc.

- d. Symcom, Inc.
- e. Warrick Controls.
- 4. Solid-State Timers:
 - a. Rockwell.
- 5. Terminal Blocks:
 - a. Allen-Bradley (Type 1492F1 or Type 1492CA1).
 - b. Altech (Type CTS4U-N).
 - c. Square D Co. (Class 9080, Type KCA-1).
 - d. Thomas & Betts (100 series or 200 series).
 - e. Weidmueller (SAKD2.5N or SAK2.5).
- 6. Fusible Terminal Blocks:
 - a. Allen-Bradley (Type 1492-H6)
- 7. Textured Polyurethane Enamel:
 - a. Sherwin-Williams, Polane T and/or Polane HST.
- 8. Wire Markers:
 - a. Brady.
 - b. T&B.
 - c. Westline.
- 9. Control Power Transformers:
 - a. Acme
 - b. Sola MCR

2.02 CONTROL PANELS

A. Sheet Metal Construction:

1. Panels 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 or as shown on drawings. 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 white letters engraved on a black 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. Graphic plates, when used, shall be fastened to panel frame with fasteners not visible from front of graphic.
3. 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.
4. 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. Pneumatics:

1. Interior panel piping shall be grouped, supported, and terminated at bottom of panel at bulkhead fittings unless indicated otherwise. Terminations shall be clearly tagged.
2. Tubing shall be color-coded per ISA RP7.2. Pneumatic systems shall be tested per ISA RP7.1.

E. 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. 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.

F. 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. 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.
- B. Intrinsically Safe Isolator Relay:
 1. Intrinsically safe relay shall be provided between raw sewage floats and control circuits or where shown on Drawings.
 2. Relay shall operate at 120 VAC plus 10 percent with a switch rating of 1 amp rms and maximum holding current of 20 milliamp for solid-state devices. Relay shall be rated for ambient temperatures of 32 degrees F to 120 degrees F.
 3. Output shall be N.O. or N.C. Equipment supplier is responsible for choosing proper output for float specified and circuits specified. If float and circuit are not defined, intrinsically safe relay shall be of such a polarity as to fail in a safe condition for function being performed.
 4. When intrinsically safe relay is required in panels exposed to outdoor temperatures, relays shall be rated for ambient temperatures of -40 to 120 degrees F, or thermostatically controlled heaters must be added to panel to maintain an ambient in panel of 32 to 120 degrees F.

2.05 TIMING DEVICES

- A. Solid-state timers shall be plug-in type.
- B. Solid-state timers with ON or OFF delay cycles shall operate at 120 VAC, 60 hertz. Solid-state device may be analog or digital in operation. Time interval shall be as shown on Drawings or as required.
- C. Solid-state repeat cycle timers with adjustable ON-OFF cycles shall operate at 120 VAC, 60 hertz. Solid-state device may be analog or digital in operation. Time interval shall be as shown on Drawings or as required.

2.06 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. |
| Light Blue | Intrinsically Safe Circuits (IS). |
- 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.

2.07 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.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 15014 – PRESSURE TESTING OF PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section specifies the leakage testing requirements for all drains, chemical piping and service water, utility water and non-potable water piping.
- B. Related Work Described Elsewhere
 - 1. Process mechanical equipment are included under Division 11.
 - 2. Mechanical piping valves, pipe hangers, accessories, and appurtenances are included under Division 15.

1.02 QUALITY ASSURANCE

- A. Test Pressures: Test pressures for the various services and types of piping shall be as shown on plans. At a minimum, testing pressure shall be 1.5 times the working pressure

1.03 SUBMITTALS

- A. Materials and Shop Drawings (Not Applicable)
- B. Additional Information:
 - 1. Testing Plan: Submit prior to testing and include at least the information that follows
 - a. Testing dates
 - b. Piping systems and section(s) to be tested
 - c. Test type
 - d. Method of isolation
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested
 - 2. Certifications of Calibration: Testing equipment
 - 3. Certified Test Report
 - 4. Testing Records
 - a. Provide a record of each piping installation during the testing. These records shall include
 - 1) Date of test
 - 2) Identification of pipeline tested or retested
 - 3) Identification of pipeline material
 - 4) Identification of pipe specification
 - 5) Test fluid
 - 6) Test pressure
 - 7) Remarks: Leaks identified (type and location), types of repairs, or corrections made
 - 8) Certification by Contractor that the leakage rate measured conformed to the specifications.
 - b. Submit the test records to Owner and Engineer upon completion of the testing

PART 2 - PRODUCTS

2.01 GENERAL

- A. Testing fluid shall be clean water for all piping except air service and shall be of such quality to prevent corrosion of materials in piping system for all hydrostatic tests. Air piping shall be tested using compressed air.

2.02 MATERIALS AND EQUIPMENT

- A. Provide all pressure gauges, necessary bracing and restraint, test plugs, pipes, bulkheads, pumps, and meters to perform the hydrostatic and pneumatic testing.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Pipes shall be in place and anchored before commencing pressure testing.
- B. Conduct hydrostatic and pneumatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.
- C. Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. For pneumatic tests, blow air through the pipes.
- D. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.
- E. Conduct hydrostatic tests on buried pipe after the trench has been completely backfilled. The pipe may be partially backfilled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.
- F. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.
- G. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Owner.
- H. Items that do not require testing include: Piping between wet wells and wet well isolation valves, equipment seal drains, and tank atmospheric vents.
- I. Gravity Piping:
 - 1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 - 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Owner.

J. Pressure Test:

1. All tests shall be made in the presence of and to the satisfaction of the Program Manager/Engineer and Owner and also, to the satisfaction of any local or state inspector having jurisdiction.
 - a. Provide not less than three (3) days notice to the Owner and the authority having jurisdiction when it is proposed to make the tests.
 - b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Owner shall be retested in part or in whole as directed by the Owner.
 - c. The piping systems may be tested in sections as the work progresses, but no joint or portion of the system shall be left untested.
2. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.
3. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

3.02 INSPECTION AND TESTING

- A. Hydrostatic Testing of Aboveground or Exposed Piping: The maximum filling velocity shall be 0.25 feet per second, applied over full area of pipe. Open vents at high points of the piping system to purge air while the pipe is being filled. Subject the piping system to the test pressure indicated. Maintain the test pressure for a minimum of four (4) hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show no leakage or weeping. Correct leaks and retest until no leakage is obtained.
- B. Hydrostatic Testing of Buried Piping:
 1. Test after backfilling has been completed. Expel air from piping system during filling.
 2. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortarlined piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.
 3. Apply and maintain the test pressure by means of a hydraulic force pump. Maintain the test pressure for a minimum duration of four (4) hours. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure during the four hours. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula.

$$L = \frac{SD(P)^{1/2}}{133,200}$$

in which:

L = allowable leakage (gallons/hour) during the test period.

S = length of pipe, in feet

D = diameter of the pipe (inches)

P = specified test pressure (psig)

4. Repair and retest any pipes showing leakage rates greater than that allowed.

C. Hydrostatic Test For Gravity Piping:

1. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.

2. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
 3. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.
 4. Exfiltration Test:
 - a. Hydrostatic Head:
 - 1) At least 6 feet above maximum estimated groundwater level in section being tested.
 - 2) No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
 5. Infiltration Test:
 - a. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.
 6. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
 7. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.
- D. Test Pressure:
1. All pipe shall be tested at pressures shown on plans. If not listed, at a minimum, testing pressure shall be 1.5 times the normal working pressure working pressure of the pipe.

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. These drawings shall be reproducible and submitted on tracing, mylar or sepia paper.
 - 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 01600, 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.
- B. Materials and Equipment: Unless otherwise specified, all materials and equipment furnished for permanent installation in the work shall conform to applicable standards and specifications and shall be new, unused, and undamaged when installed or otherwise incorporated in the work. No such material or equipment shall be used by the Contractor for any purpose other than that intended or specified, unless such use is specifically authorized in writing by the Owner. No material shall be delivered to the work site without prior acceptance of drawings and data by the Owner.
- C. Equivalent Materials and Equipment:
 - 1. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function, and quality desired. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Owner to determine that the products proposed are equivalent to those named. Such items shall be submitted for review in accordance with Section 01330 – Submittals.
 - 2. Requests for review of equivalency will not be accepted from anyone except the Contractor and such requests will not be considered until after the contract has been awarded.
- D. Governing Standards: Equipment and appurtenances shall be designed in conformity with ANSI, ASME, ASTM, IEEE, NEMA, OSHA, AGMA, and other generally accepted applicable standards. They shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation, and all conditions or operations. All bearings and moving parts shall be adequately protected against wear by bushings or other acceptable means. Provisions shall be made for adequate lubrication with readily accessible means.
- E. Tolerances: Machinery parts shall conform to the dimensions indicated on the drawings within allowable tolerances. Protruding members such as joints, corners, and gear covers shall be finished in appearance. All exposed welds shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.
- F. Clearances: Ample clearances shall be provided for inspection and adjustment. All equipment shall fit the allotted space and shall leave reasonable access room for servicing and repairs. Greater space and room required by substituted equipment shall be provided by the Contractor and at his expense.
- G. Testing:
 - 1. When the equipment is specified to be factory tested, the results of the tests shall be submitted to the Owner and approval of the test results shall be obtained before shipment of the equipment.
 - 2. When an item of equipment, including controls and instrumentation, has been completely erected, the Contractor shall notify the Owner, who will designate a time to make such tests as required, and operate the item to the satisfaction of the Contractor. All testing shall be done in

the presence of the Contractor. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned and painted.

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.
- B. Packaging: All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.
- C. Protection: All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage as specified in Sections 09900 – Paints and Coatings. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Owner.
- D. Lubrication: Grease and lubricating oil shall be applied to all bearings and similar items as necessary to prevent damage during shipment and storage.
- E. Marking: Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.
- F. Fabricated sub-assemblies, if any, shall be shipped in convenient sections as permitted by carrier regulations and shall be properly match-marked for ease of field erection.
- G. Responsibility:
 - 1. The Contractor shall be responsible for all material, equipment, and supplies sold and delivered to the site under this Contract until final inspection of the work and acceptance thereof by the Owner. In the event any such material, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the Contractor shall replace same without additional cost to the Owner.
 - 2. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven days after written notice to do so has been given, the Owner retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the Contractor's Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.
- H. Delivery: The Contractor shall arrange deliveries of products in accordance with construction schedules and coordinate to avoid conflict with work and condition at the site.
 - 1. The Contractor shall deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
 - 2. Immediately on delivery, the Contractor shall inspect shipments to assure compliance with requirements of Contract Documents and accepted submittals, and that products are properly protected and undamaged.

3. Under no circumstances shall the Contractor deliver equipment to the site more than one month prior to installation without written authorization from the Owner. Operation and maintenance data shall be submitted to the Owner for review prior to shipment of equipment as described in Section 01730 – Operation and Maintenance Data.
- I. Storage and Protection of Products:
1. The Contractor shall furnish a covered, weather-protected storage structure providing a clean, dry noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the "Instructions for Storage" of each equipment supplier and manufacturer including connection of space heaters, and placing of storage lubricants in equipment. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.
 - a. The Contractor shall store products subject to damage by the elements in weathertight enclosures.
 - b. The Contractor shall maintain temperature and humidity within the ranges required by manufacturer's instructions.
 - c. The Contractor shall store fabricated products above the ground, on blocking or skids, to prevent soiling or staining. The Contractor shall cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation to avoid condensation.
 - d. The Contractor shall store loose granular materials in a well drained area on solid surfaces to prevent mixing with foreign matter.
 2. All materials and equipment to be incorporated in the work shall be handled and stored by the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind whatsoever to the material or equipment.
 3. Cement, sand, lime shall be stored under a roof and off the ground, and shall be kept completely dry at all times. All structural and miscellaneous steel and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt, or grease, and in a position to prevent accumulations of standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking and peeling to a minimum.
 4. All materials which, in the opinion of the Owner, have become damaged and are unfit for the use intended or specified, shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the damaged material or its removal.
 5. The Contractor shall arrange storage in a manner to provide easy access for inspection. The Contractor shall make periodic inspections of stored products to assure products are maintained under specified conditions, and free from damage or deterioration.
 6. Protection After Installation: The Contractor shall provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. The Contractor shall remove covering when no longer needed.
- J. Extended Storage Requirements For Equipment: Because of the long period allowed for construction, special attention shall be given to extended storage and handling of equipment onsite. As a minimum, the procedure specified herein shall be followed:
1. If equipment will be stored onsite for more than one month prior to incorporation into the Work, the Contractor shall submit a written request to the Owner outlining any special provision to be made to protect and maintain the equipment while it is being stored. All such provisions shall be acceptable to the Owner. No equipment shall be stored onsite for more than one month without prior written authorization from the Owner.

2. All equipment having moving parts including gears, electric motors, and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Owner, until such time as the equipment is to be installed.
3. All equipment shall be stored fully lubricated with oil and grease unless otherwise instructed by the manufacturer.
4. Manufacturer's storage instructions shall be carefully studied by the Contractor and reviewed by him with the Manufacturer's Representative. These instructions shall be carefully followed and a written record of this review kept by the Contractor.
5. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, and operate loaded when possible, weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety days, shall have the bearings cleaned, flushed, and lubricated prior to testing and startup, at no extra cost to the Owner.
7. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective, and it shall be removed and replaced at the Contractor's expense.
8. A maintenance log shall be maintained by the Contractor outlining the schedule of maintenance required for each piece of equipment as well as the date on which the maintenance was actually performed and the initials of the individual performing the work. Submit the maintenance log monthly with the progress pay application.

1.05 PROJECT CONDITIONS

- A. Explosion-proof Requirements: All work and equipment located in areas designated "Explosion-proof" shall conform to all requirements of Article 500 of the National Electric Code for Class 1, Division 1, Group. D installations, except when otherwise noted. All mechanical equipment located in these areas shall be built from nonsparking material per AMCA Std. 401-66 Type B.
- B. Corrosive Area Requirements: All heating, ventilating and air conditioning equipment, controls, ductwork, piping, supports and hangers shall be made of materials resistant to the chemicals or gases to which they are exposed, or be coated with the appropriate resistant coatings.
 1. The following is a partial list of areas which require equipment, piping, ductwork, supports, anchors etc. to be corrosion treated:
 - a. grit and screen rooms,
 - b. enclosed primary sanitary treatment structures,
 - c. chemical storage and handling areas,
 - d. filter areas,
 - e. high-humidity areas,
 - f. wet wells, and
 - g. other areas as indicated on Drawings.

2. Acceptable Manufacturers: Products shall meet the requirements of this Section and be the product of:
 - a. Liberty Plastics.
 - b. Plasite (Wisconsin Protective Coating Corp.).
 3. Hanger, supports, anchors in corrosive areas shall be 316 stainless steel or FRP unless otherwise noted on the drawings or herein.
- C. 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.
- D. 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.
- E. 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:
 - a. L Seton Name Plate Corporation
 - b. W.H. Brady
 - c. James H. Matthews
 - d. 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 and 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 08310.

- 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:
 - 1. Seton Name Plate Corporation
 - 2. W.H. Brady
 - 3. Topflight Tape Company
 - 4. James H. Matthews
 - 5. Approved equal.
- D. Paint or stencil 1-1/2 inch high black enamel block type letters or numerals on all equipment items

3.04 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.

3.05 START-UP AND INSTRUCTION

A. Services Furnished Under This Contract:

1. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Owner.
2. Each manufacturer's representative shall furnish to Owner and Contractor, a letter of certification stating that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.
3. All costs for field services shall be included in the contract amount.

END OF SECTION

SECTION 15060 - SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of pipe hangers, supports, concrete inserts, and anchor bolts including all metallic hanging and supporting devices for supporting exposed piping, indicated on Drawings and/or specified in other Division 15 Sections.
- B. Types of supports and anchors include the following:
 - 1. Horizontal piping hangers and supports.
 - 2. Vertical piping clamps.
 - 3. Hanger rod attachments.
 - 4. Building attachments.
 - 5. Saddles and shields.
 - 6. Spring hangers and supports.
 - 7. Miscellaneous materials.
 - 8. Anchors.
 - 9. Equipment supports.
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 15 Sections.

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 assembly type Shop Drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
 - 2. Submit manufacturer's technical product data, including installation instructions, for each type of support and anchor.
 - 3. Product Data: submit manufacturer's catalog data including load capacity.
 - 4. Drawings shall indicate system layout with location – including critical dimensions, sizes, and pipe hanger and support locations – and detail of trapeze hangers, anchors, and guides.
 - 5. Submit signed and sealed Shop Drawings with design calculations and assumptions for load carrying capacity of trapeze, multiple pipe, and riser support hangers.
 - 6. Submit calculations sealed by a registered professional engineer in the State of Michigan.
- B. Submit to the Owner, for approval, samples of all materials specified herein.
- C. Spare Parts: Furnish one set of manufacturer's recommended spare parts.
- D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include maintenance data and parts list for each type of support and anchor.

1.03 QUALITY ASSURANCE

- A. Supports and hangers specified in this section shall be compatible with the Orthophosphate chemical liquid contained in the pipes and tanks.

- B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- C. Hangers and supports shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for pipe supports shall be five (5) times the ultimate tensile strength of the material, assuming 10 feet of water filled pipe being supported.
- D. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, the Contractor shall submit a certification stating that such requirements have been complied with.
- E. Codes and Standards:
 - 1. Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
- F. Manufacturers Standardization Society of the Valves and Fittings Industry, Inc. (MSS) Standard Compliance:
 - 1. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - 2. Select and apply pipe hangers and supports complying with MSS SP-58.
 - 3. Fabricate and install pipe hangers and supports complying with MSS SP-89.
 - 4. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Hangers and Supports:
 - a. B-Line Systems, Inc.
 - b. Carpenter and Patterson, Inc.
 - c. Corner & Lada Co., Inc.
 - d. Elcen Metal Products Co.
 - e. Fee & Mason Mfg. Co., Div. Figgie International.
 - f. Anvil International.
 - 2. Saddles and Shields:
 - a. Elcen Metal Products Co.
 - b. Pipe Shields, Inc.

2.02 MATERIALS

- A. Hangers, supports, and anchors shall be 316 stainless steel or FRP construction in corrosive environments unless otherwise specified herein or on the drawings.

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping systems, in accordance with MSS SP-58 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper piping systems.
1. Adjustable Steel Clevis Hangers: MSS Type 1.
 2. Pipe Hangers: MSS Type 5.
 3. Adjustable Band Hangers: MSS Type 9.
 4. Adjustable Roller Hangers: MSS Type 43.
 5. Pipe Roll Stands: MSS Type 44.
 6. Pipe Rolls and Plates: MSS Type 45.
 7. Adjustable Pipe Roll Stands: MSS Type 46.

2.04 VERTICAL PIPING CLAMPS

- A. Except as otherwise indicated, provide factory fabricated vertical piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-58 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems.
1. Two-Bolt Riser Clamps: MSS Type 8.

2.05 PIPE SUPPORTS FOR SMALL DIAMETER PVC, CPVC AND STEEL PIPE:

- A. Small diameter Schedule 80 PVC piping 3-inches in diameter and smaller, and steel piping 2-inches in diameter and smaller shall be supported with "SUSPORT" system arrangements as manufactured by Universal Suspension Systems Inc. of Gillette, New Jersey or an equal approved by the Owner. Clamping halves for the pipe support shall be manufactured of molded polypropylene and shall support and fit closely for 360° around the pipe. To support piping carrying non-corrosive fluids or gases and located in noncorrosive, indoor environments, all hardware for the "SUSPORT" system shall be nickel chrome plated carbon steel. To support piping carrying corrosive fluids or gases, piping located in corrosive environments or piping located outdoors, all hardware for the system shall be as indicated in the contract drawings.
- B. In some cases, to adequately support small diameter PVC or steel piping, a metal frame support structure may be required for support of the "SUSPORT" system specified above. Where required, metal frame support structures shall be constructed using channels, fittings, brackets, hardware and other accessories as manufactured by B-Line Systems, Inc. of Highland, Illinois, or an equal approved by the Owner. If located in indoor, non-corrosive environments, the materials for the frame structure shall be carbon steel with an epoxy coating applied by a cathodic, electro-deposition process which is equal to "Dura-a-Green" by B-Line Systems, Inc. For corrosive or outdoor environments, the materials for the frame structure be Type 316 stainless steel unless otherwise noted on the Drawings. Hardware used to construct the frame support structure shall be cadmium plated for carbon steel supports or Type 316 stainless steel for stainless steel supports.
- C. Pipe supports for small diameter PVC and steel piping shall be located wherever necessary in the opinion of the Owner to adequately support the pipe, however, they shall have a maximum spacing

as specified below for straight pipe runs. Adequate supports shall especially be used adjacent to valves and fittings in pipelines. The following table is based on spacing requirements for Schedule 80 PVC or Standard Weight (Schedule 40) steel pipe carrying a fluid with a Specific Gravity of 1.0 at a temperature not exceeding 120°F. Support spacing for PVC or steel piping carrying fluids with Specific Gravities or temperatures exceeding those stated above shall be approved by the Owner.

Nominal Pipe Diameter, Inches	Support Spacing, Feet PVC Pipe	Steel Pipe
1/2"	3.5	4.5
3/4"	4.0	5.0
1"	4.5	5.5
1-1/4"	5.0	6.5
1-1/2"	5.0	7.5
2"	5.5	8.0
2-1/2"	5.5	-
3"	6.0	-

2.06 CHEMICAL FEED PIPING SYSTEMS:

1. All pipe supports and fasteners shall be glass fiber-reinforced plastic with a flame spread rating of 25, in accordance with ASTM E 84. Stainless Steel 304 or 316 is not acceptable. All hardware to be fiber-reinforced plastic made from vinylester resin.
2. Material shall be compatible with Carus 8700 Orthophosphate chemical.
3. Materials shall be manufactured by either the pultrusion or extrusion process.
4. All pipe supports shall have a surface veil over 100 percent of the surface which, along with a filler system, shall protect against degradation from ultra-violet light.
5. All fasteners shall be manufactured from long glass fiber-reinforced polyurethane to ensure strength and corrosion resistance.
6. All-thread rods shall be made from vinylester resin.
7. Manufacturers: Provide products of one of the following:
 - a. Unistrut Company.
 - b. Or equal.

2.07 HANGER-ROD ATTACHMENTS

- A. Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping hangers and building attachments, in accordance with MSS SP-58 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper piping systems.
 1. Steel Turnbuckles: MSS Type 13.
 2. Malleable Iron Sockets: MSS Type 16.
 3. Steel Weldless Eye Nuts: MSS Type 17.

2.08 BUILDING ATTACHMENTS

- A. Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions in accordance with MSS SP-58 and manufacturer's published product information. Select

size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems.

1. Concrete Inserts: MSS Type 18. Inserts for concrete shall be galvanized steel, 316 stainless steel or galvanized malleable iron. Inserts shall be 316 stainless steel for all applications in wastewater treatment and water treatment process areas unless otherwise noted on drawings.
2. Top Beam Clamps: MSS Type 25.
3. Steel Brackets:
 - a. Side Beam Brackets: MSS Type 34.

2.09 SADDLES AND SHIELDS

- A. Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
- C. Protection Shields: MSS Type 40, of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal Hanger Shields: Constructed of 360-degree insert of high density, 100 psi, waterproof calcium silicate, encased in 360-degree sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.10 SPRING HANGERS AND SUPPORTS

- A. Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit piping systems in accordance with MSS SP-58 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.
 1. Restraint Control Devices: MSS Type 47.
 2. Spring Cushion Hangers: MSS Type 48.

2.11 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA Standard ML 1.
- B. Steel Plates, Shapes, and Bars: Provide products complying with ANSI/ASTM A 36.
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1 part cement to 3 parts sand, by volume, with minimum amount of water required for placement and hydration.
- D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

- E. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted 2-section outer cylinder and base with 2-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

- A. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the Work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors, and associated Work, Installer shall meet at Site with CONTRACTOR, Installer of each component of associated Work, inspection and testing agency representatives (if any), Installers of other work requiring coordination with Work of this Section, and ENGINEER for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.03 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-58. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-58. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire-water piping independently of other piping.

- D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper-plated or by other recognized industry methods.
- E. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - 2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.1 Pressure Piping Codes are not exceeded.
- F. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.1.
 - 2. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8-inch and over, install wood insulation saddles.
 - 3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.05 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.1, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.1 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for pre-set of anchors as required to accommodate both expansion and contraction of piping.

3.06 EQUIPMENT SUPPORTS

- A. Furnish to CONTRACTOR, scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
- B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.07 ADJUSTING AND CLEANING

- A. Adjust hangers so as to distribute loads equally on attachments.

- B. Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 15062 - CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations and of the size as shown on the Drawings and specified herein Schedule 80 Chlorinated Polyvinyl Chloride (CPVC) piping, fittings and appurtenances.
- B. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.

1.02 QUALITY ASSURANCE

- A. CPVC pipe, fittings and appurtenances shall meet the following standards:
 - 1. Pipe - ASTM D1784/ASTM F441, Type IV, Grade I, CPVC 4120, Schedule 80, Cell Classification 23447-A, bearing NSF seal.
 - 2. Fittings - ASTM D2464 or D2467, Cell Classification 23447-A, bearing NSF seal.
 - 3. Flanges - Diameter and drilling shall conform to ANSI B16.5, Class 150.
 - 4. Flange Bolts and Nuts - Flange bolts and nuts shall conform to ASTM F593 and F594 respectively.
 - 5. Flat Washers - Shall be of the same material as the bolts.
 - 6. Flange Gaskets - Full face, 1/8 inch thick, chemical-resistant elastometric material suitable for the specified service.
 - 7. Solvent Cement - ASTM D2564.
 - 8. Primer - ASTM F656.
 - 9. Expansion Joints - Edlon "Thermo-molded TFE", Resistoflex "Style R6905".

1.03 SUBMITTALS

- A. Materials and Shop Drawings:
 - 1. Shop drawings shall be submitted to the Owner for approval in accordance with the General Requirements and Section 01330. All products within this specification shall be combined into a single submittal which shall include at least the following:
 - a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.
 - b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.
 - c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.
- B. Additional Information:
 - 1. Submit to the Owner, for approval, samples of all materials specified herein, along with the manufacturer's descriptive literature, illustrations, specifications, installation instructions and related information.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Pipe and fittings shall be handled and stored in a manner which will ensure installation in sound, undamaged condition. Handling methods and equipment used shall prevent damage to pipe. Bare cables, chains, or metal bars shall not be used. Pipe shall be stored off the ground on wide padded skids.

1.05 WARRANTY

Provide equipment warranty for a period of two years, in accordance with Section 01600, Material and Equipment.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water.

2.02 MATERIALS AND EQUIPMENT

- A. Piping for buried service:
 - 1. Pipe and fittings:
 - a. Pipe and fittings shall be gasketed style utilizing twin gasket coupling or single gasket bell and spigot unless otherwise shown on the Drawings.
 - b. Pipe lengths: Laying length of 20 feet or as shown on the Drawings.
 - 2. Joints:
 - a. Provide rubber gaskets in sufficient quantity to allow for loss.
 - b. Provide couplings of the same quality as the pipe that will maintain tight joints when subjected to the same hydrostatic tests designated for the pipe.
 - 3. Adapters: When applicable, provide adapters for connecting chlorinated polyvinyl chloride pipe to pipes constructed from other material.
- B. Piping for exposed service:
 - 1. Pipe and fittings:
 - a. Solvent weld for piping unless otherwise shown on the Drawings or specified in other Sections in the Division.
 - b. Chemical piping, fittings and components: Schedule 80 CPVC, normal impact unless otherwise shown on the Drawings or specified in other Sections in this Division.
 - 2. Joints:
 - a. Solvent weld using solvent supplied or approved by pipe manufacturer. : For all non-chemical associated pipes.
 - b. Couplings and fittings: Minimum schedule and pressure rating as the pipe.
 - 3. Provide suitable adapters for connections to equipment and other piping systems.
- C. Solvent Cement: Non-chemical Pipes
 - 1. CPVC solvent cement shall be in compliance with ASTM D 2564.
 - 2. Solvent cement shall be specified by compatibility based on pipe service and size.

D. Flanges:

1. The Contractor shall provide flanges on CPVC piping to connect to flanged valves, fittings, or equipment and as shown in the Drawings. Flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment and must meet the test pressure of the piping system as specified in Section 15014: Pressure Testing of Piping.
2. Except for higher pressure flange connections that may be required as noted above, flanges shall meet ANSI B16.5 and be rated for an internal pressure of 150 psi at 73-degrees F.
3. Flange hardware (bolts, nuts, and washers) for CPVC flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively, and shall be furnished with a bright electropolished finish. Bolt length shall be provided such that bolts will project 1/8 to 3/8 inch beyond the outer face of the nut.
4. For chemical feed piping systems, the gasket material shall be selected by the gasket manufacturer based on the chemical concentrations as specified in Divisions 11 and 13.

2.03 SPARE PARTS

- A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe.

2.04 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install CPVC pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.
- B. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded and threaded CPVC pipe joints shall be in strict accordance with the pipe and fitting manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.
- C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.
- D. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Owner.
- E. Where plastic passes through wall sleeves, joints shall be sealed with a mechanical seal equal to Link-seal.
- F. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the

Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings. Pipe Supports for Process Piping are specified in Section 15060.

G. Jointing:

1. Clean each pipe length, coupling and fitting of all debris and dirt before installation.
2. Do not use pipe length if there are any cuts, abrasions, or defects on the surface of the pipe.
3. Provide and use coupling pullers for joining the pipe when required.
4. Shove home each length of pipe against the pipe previously laid and hold securely in position.
5. Do not pull or cramp joints.

H. Fabrication:

1. Cutting:
 - a. Use a hand saw or pipe cutter with blades (not rollers).
 - b. Examine all cut ends for possible cracks caused by cutting.
2. Connecting:
 - a. Connect pipe and fittings only when temperature is above the minimum recommended by the manufacturer.
 - b. Threaded adapters shall be connected only with plastic male into metal female.

3.02 INSPECTION AND TESTING

- A. All CPVC pipe shall be pressure tested in accordance with Section 15014 – Pressure Testing of Piping.

END OF SECTION

SECTION 15063 - POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS, SCHEDULE TYPE

1.01 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals required, and install and test in the locations as shown on the Drawings, the Schedule 80 polyvinyl chloride piping, fittings and appurtenances specified herein.
- B. Schedule 80 PVC piping shall be used on all small diameter PVC piping systems (4 inches and smaller in diameter) which includes, but are not limited to, chlorine solution, non-potable water, potable water, other chemical feeds and PVC pipe used for conduit/sleeve applications.
- C. Polyvinyl chloride (PVC) gravity sewer pipe and fittings shall be in accordance with ASTM D 3034 for piping NPS 15 and smaller, and to ASTM F 679 for piping NPS 19 and larger diameter.
- D. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.

1.02 REFERENCES

- A. ASTM Internation (ASTM):
 - 1. D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 2. D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - 3. D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - 4. D 2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - 5. D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - 6. D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
 - 7. F 645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.
- B. NSF International (NSF):
 - 1. 61 – Drinking Water System Components – Health Effects

1.03 QUALITY ASSURANCE

- A. All plastic pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.04 SUBMITTALS

- A. Materials and Shop Drawings:
 - 1. Shop drawings shall be submitted to the Owner for approval in accordance with the General Conditions and Section 01330. All products within this specification shall be combined into a single submittal which shall include at least the following:

- a. Dimensioning and the technical specification for all piping, fittings, and appurtenances to be furnished.
- b. Letter of Certification from the National Sanitation Foundation International (NSF) stating compliance with Standard 14 and Standard 61.
- c. Letter from the Manufacturer verifying chemical compatibility of all products to be used in chemical feed systems.

B. Additional Information:

1. Submit to the Owner, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. PVC pipe shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible, pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a forklift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.
- B. When it is necessary to store PVC pipe for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. PVC pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.
- C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All materials that come into contact with the water being treated or the finished water shall be NSF Standard 61 certified for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating NSF Standard 61 for the materials used in products that come into contact with the water.

2.02 MATERIALS AND EQUIPMENT

A. PVC Pipe:

1. Pipe shall be made of polyvinyl chloride, Schedule 80 pipe, conforming to ASTM D1785. Schedule 80 pipe shall have solvent welded joints. Threaded connections are permissible when connecting to valves or other equipment where solvent weld connections are not an option. In no cases is connection of PVC female threads to metal male threads allowable. Female threads shall be special reinforced with stainless steel collars. Male threads shall be reinforced with stainless steel insert.

- B. Fittings:
1. Fittings for Schedule 80 pipe 4 inches and smaller in diameter shall be socket type, solvent welded in conformance with ASTM D 2467. When permitted, threaded joints shall be in conformance with ASTM D 2464. Solvent welded and threaded joints shall be watertight. Chlorine gas vacuum feed lines and chlorine solution lines shall have solvent welded fittings. Female threads shall be special reinforced with stainless steel collars. Male threads shall be reinforced with stainless steel insert.
 2. Fittings for Schedule 80 pipe greater than 4 inches in diameter shall be socket type, solvent welded in conformance with ASTM D 2467. Fittings shall be a 1-piece injection molded design. Use of low pressure fabricated PVC fittings will not be permitted.
- C. Solvent Cement:
1. PVC solvent cement shall be in compliance with ASTM D 2564.
 2. Solvent cement shall be specified by compatibility based on pipe service and size. Large diameter joints shall be solvent welded with slow setting solvent cement.
 3. Manufacturer to provide certification with submittal.
 4. All PVC chemical feed piping joints are to be solvent welded using CPVC solvent cement.
- D. Flanges:
1. Slip-on flanges shall be provided to connect to flanged valves, fittings, or equipment. Flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment and must meet the test pressure of the piping system as specified in Section 15014.
 2. Flange hardware (bolts, nuts, and washers) for PVC flanges shall be Type 316 stainless steel in accordance with ASTM F593 and F594, respectively. The length such that, after installation, bolts will project 1/8 to 3/8 inch beyond the outer face of the nut. Flat Washers shall be of the same material as the bolts.
 3. Flange gaskets shall be EPDM for water service.
- E. PVC Gravity Sewer Piping
1. Polyvinyl chloride (PVC) gravity sewer pipe and fittings: In accordance with ASTM D 3034 for piping NPS 15 and smaller diameter, and to ASTM F 679 for piping NPS 18 and larger diameter:
 - a. Referenced standards apply as complemented and modified in this Section.
 - b. Fittings: Supplied by the pipe manufacturer.
 2. PVC compounds: Class Number 12454-C, in accordance with ASTM D 1784:
 - a. Stabilizers, antioxidants, lubricants, colorants, and other additives and fillers: Not to exceed 10 parts by weight per 100 of PVC resin in the compound.
 3. Pipe NPS 15 and smaller diameter: Wall thickness SDR 26:
 - a. Joints: Push-on joints in accordance with ASTM D 3212.
 4. Pipe NPS 18 and larger diameter:
 - a. PVC compound: Cell classification 12454-C in accordance with ASTM D 1784.
 - b. Minimum wall thickness: Thickness T-1 in accordance with Table 1 in ASTM F 679.
 - c. Joints: Integral bell gasketed joints in accordance with ASTM F 679.
 - d. Bell: Fabricated from pipe sections, thickness of the wall of the bell equivalent to the pipe wall thickness.
 - e. Gasket ring: Locked into the bell.
 - f. Spigot end of the pipe: Marked by the manufacturer to identify the final in-place position of the spigot in the bell.
 5. Fittings, including wyes, tees, elbow caps, plug adapters, and manhole waterstops: Same wall thickness as the pipe:
 - a. Fittings: Factory molded with joints and gaskets equal to those of the pipe.
 6. Gasket: EPDM in accordance with ASTM D 3212 or ASTM F 477:
 - a. Keep rubber gasket in place during pipe joining.

7. Gasket for connection to manhole: Stainless steel clamp with gasket or similar device to seal the penetration.
 - a. Keep rubber gasket in place during pipe joining.

2.03 SPARE PARTS

- A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe

2.04 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install PVC pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.
- B. Joints for Schedule 80 PVC pipe and fittings shall be solvent welded, flanged, or threaded. All joints shall be made watertight. All pipe cutting, threading and jointing procedures for solvent welded and threaded PVC pipe joints shall be in strict accordance with the pipe and fittings manufacturer's printed installation instructions. Thread lubricant for threaded joints shall be Teflon tape only. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.
- C. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. Particular care shall be taken not to over-stress threaded connections at sleeves. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.
- D. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings. Pipe hangers and supports are specified in Section 15060
- E. Field Painting:
 1. Pipe normally exposed to sunlight shall be painted and marked as specified in Section 09900.
- F. Joining:
 1. Join pipe in strict accordance with manufacturer's instructions for joining pipe. Pay special attention to proper methods for solvent welding pipe, especially with larger pipe diameters.
 2. Clean each pipe length, coupling and fitting of all debris and dirt before installation.
 3. Do not use pipe length if there are any cuts, abrasions, or defects on the surface of the pipe.
 4. Provide and use coupling pullers for joining the pipe when required.
 5. Shove home each length of pipe against the pipe previously laid and hold securely in position.
 6. Do not pull or cramp joints.
- G. Fabrication:
 1. Cutting:
 - a. Use a hand saw or pipe cutter with blades (not rollers).
 - b. Examine all cut ends for possible cracks caused by cutting.
 2. Connecting:
 - a. Solvent weld connections as recommended by the manufacturer.

- b. Connect pipe and fittings only when temperature is above the minimum recommended by the manufacturer.
- c. Threaded adapters shall be connected only with plastic male into metal female. Do not thread metal threads into plastic female threads.
- d. Flange pipe with appropriate adaptors for to connect to flanged valves, tank nozzles and equipment.

3.02 INSPECTION AND TESTING

- A. All PVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15014: Pressure Testing of Piping.

END OF SECTION

SECTION 15076 - DOUBLE WALL CONTAINMENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, equipment and incidentals required, and install and test the double wall containment piping, fittings and appurtenances specified herein.
 - 1. Double wall containment piping systems are required for the exterior phosphate feed piping and containment drains. The double wall containment piping shall be used when the piping is in contact with the ground, located in the trenches or overhead, or any other location indicated on the drawings.
 - 2. General Design:
 - a. Double wall containment piping shall be installed in the locations as shown on the Drawings. All plastic pipe and fittings shall conform to this specification section whether provided as a part of an equipment "package" or purchased separately by the Contractor.
 - b. Double wall containment pipe for chemical feed piping shall consist of Perfluoroalkoxy (PFA) tubing inside Schedule 80 chlorinated polyvinyl chloride (CPVC) conforming to this specification or in locations specifically called for on the drawings, shall be a pre-engineered double containment piping system constructed of schedule 80 CPVC.

1.02 SUBMITTALS

- A. Materials and Shop Drawings:
 - 1. Shop drawings shall be submitted to the Owner for approval in accordance with the General Requirements and shall include dimensioning and the technical specification for all piping to be furnished.
- B. Additional Information:
 - 1. Submit to the Owner, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.
 - 2. Provide NSF 61 certification for PFA tubing.

1.03 QUALITY ASSURANCE

- A. All Schedule 80 CPVC and PFA tubing double containment piping including fittings and appurtenances shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.
- B. Solvent welder shall be qualified in accordance with Chapter VII of the ASME B31.3-93 Code, Part 9, Paragraph A328.
- C. Piping shall be marked with nominal size, type, class, schedule or pressure rating, manufacturer and all markings required by applicable ASTM and AWWA standards.

- D. CPVC Schedule Type Piping shall be Schedule 80 unless otherwise indicated on the Drawings. Pipe and fittings shall be extruded from Type I, Grade I, Class 12454-B material in accordance with ASTM D 1784.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. PVC containment pipe and PFA carrier tubing shall be delivered to the site in unbroken bundles packaged in such manner as to provide protection against damage. When possible, pipe should be stored at the job site in the unit packages until ready for use. Packaged units shall be handled using a fork lift or a spreader bar with fabric straps. Packaged units shall not be stacked at the job site higher than two units high.
- B. When it is necessary to store PVC containment pipe and PFA tubing for more than 30 days, exposure to direct sunlight shall be prevented by covering the pipe with an opaque material. Adequate air circulation above and around the pipe shall be provided as required to prevent excessive heat accumulation. Double wall containment pipe shall not be stored close to heat sources or hot objects such as heaters, fires, boilers or engine exhaust. Pipe gaskets shall be protected from excessive exposure to heat, direct sunlight, ozone, oil and grease. The interior and all sealing surfaces of pipe, fittings and other appurtenances shall be kept clean and free of dirt and foreign matter.
- C. Care shall be taken in handling and laying pipe and fittings to avoid severe impact blows, crushing, abrasion damage, gouging or cutting. Pipe shall be lowered, not dropped, from trucks or into trenches. All cracked, damaged or defective pipe and fittings, or any length of pipe having a gouge, scratch or other permanent indentation of more than 10 percent of the wall thickness in depth, shall be rejected and removed at once from the work and replaced with new acceptable pipe at no additional cost to the Owner.

1.05 WARRANTY

- A. Provide equipment warranty in accordance with Section 01600 Material and Equipment

PART 2 – PRODUCTS

2.01 GENERAL

- A. All double wall containment piping system components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.02 MATERIALS AND EQUIPMENT

- A. PFA Tubing and Fittings:
 - 1. Materials:
 - a. Small Bore PFA Tubing: Carrier pipe shall be of flexible virgin PFA tubing, suitable for flaring and available in continuous lengths of 25, 50, 100, 250, and 1,000 feet.
 - b. PFA tubing wall thickness shall be as follows:
 - 1) For NS 1/4-inch, 0.047-inches.
 - 2) For NS 3/8-inch, 0.062-inches.
 - 3) For NS 1/2-inch, 0.062-inches.
 - 4) For NS 3/4-inch, 0.062-inches.

- 5) For NS 1-inch, 0.062-inches.
2. Pressure ratings for PFA tubing shall be as follows:
 - a. For 1/2-inch (orthophosphate), no less than 230 psi.
3. Fittings: PFA tubing fittings shall be flare-type (no threads exposed to fluid).
4. Tubing shall be NSF 61 listed.
5. Manufacturers: Tubing shall be manufactured by Chemline Plastics Unlimited or Owner approved equal. Fittings shall be manufactured by FlareLINK by Fit-LINE, Inc., or Owner approved equal.

B. Double Containment (Hard) Piping

1. Materials:
 - a. Chemical containment hard piping shall be a prefabricated double containment piping system with sizes as shown on the drawings. Each contained piping system shall consist of Schedule 80 PVC primary piping system supported within a Schedule 80 PVC secondary containment housing for phosphate and schedule 80 CPVC primary piping system supported within a Schedule 80 CPVC secondary containment housing for phosphate.
 - b. Chemical containment pipe sizing: ½” Carrier pipe in a 2” Containment Pipe
2. Fittings:
 - a. All primary fittings shall be schedule 80 PVC according to ASTM D-2467 specifications for phosphate. All listed pressure fittings shall be schedule 80 according to ASTM D-2467.
 - b. All primary fittings shall be schedule 80 CPVC according to ASTM F-439 specifications for phosphate. All secondary containment fittings shall be schedule 80 CPVC according to ASTM F-439.
3. The double containment piping system shall be a Guardian prefabricated system as manufactured by IPEX, or equal.

2.03 ACCESSORIES

A. Leak Detection System

1. Install in strict accordance with the system manufacturer’s instructions and recommendations. Leak detection shall be installed with a sensor located in each Chemical Containment Pull Box sump and where shown on drawings, with all pipe sloping to the Chemical Containment Pull Boxes. The leak detection system shall send a signal to the SCADA in the event of a leak.
2. Where shown on the drawings, where double wall containment piping is provided and not connected to a containment pull box, the manufacturer shall provide leak detection station at low points in the line.

B. Centering Devices

1. Centering and support carrier pipe within the containment pipe with centering devices. Locate not less than every 9 feet or within 24 inches of the termination of the containment pipe on all fabricated pieces.
2. Install centering devices such that the system maintains free drainage.

2.04 SPARE PARTS

- A. All special tools, solvents, lubricants, and cements required for normal installation shall be furnished with the pipe.

2.05 QUALITY CONTROL

- A. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install double wall containment pipe where shown on the Drawings and in strict accordance with the manufacturer's technical data and printed instructions.
2. All piping shall have sufficient number of unions to allow convenient removal and shall be as approved by the Owner.
3. All valves and equipment shall be supported independently from the pipe. Anchor valves such that the turning moment resulting from their operation will not be transmitted to the pipe.

B. Installation of PVC Piping, Schedule Type:

1. Joints for double wall containment pipe and fittings shall be solvent welded. All joints shall be made watertight. All pipe cutting and jointing procedures for solvent welded pipe joints shall be in strict accordance with the pipe and fittings manufacturer's printed installation instructions. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary and apply solvent cement of proper grade.
2. Installation of valves and fittings shall be strictly in accordance with the manufacturer's instructions. In making solvent weld connections the solvent shall not be spilled on valves or allowed to run from joints.
3. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify their locations from approved piping layout Drawings and the structural Drawings.

C. Installation of Flexible Non-Metallic Tubing and Fittings:

1. Install small bore flexible tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.
2. Bundle tubing in groups of parallel tubes within protective sheath.
3. Tubes within protective sheath may be color coded but protect tubing other than black outside the sheath by wrapping with black plastic electrician's tape.
4. For buried tubing in chemical service, tubing shall be installed in Schedule 80 PVC or CPVC carrier pipe to serve as double containment. Requirements are as follows:
 - a. Carrier pipe shall utilize long radius elbows to facilitate pulling of tubing.
 - b. Carrier pipe system shall run through H-20 precast vault structures in the yard, watertight (cast with waterstops), as shown on the drawings, with an H-20 rated access hatch.
 - c. Leak detection sensor shall be :
 - 1) Asahi-Amercia Poly-Flo® system with low point sensor.
 - 2) Centra-Guard Electronic Low Point Leak Detection.
 - 3) Flowline Switch-Tek Optic Leak detection switch, Model L010-2305,
 - 4) Or approved equal.
 - d. Sensor shall be installed in the Chemical Containment Pull Box sump as shown on drawings.

- e. Drain valves for each carrier pipe shall also be installed in the vault to allow for draining of accumulated chemicals.
- f. Tubing shall be coiled inside each box to account for expansion and contraction. Coil radius shall be kept larger than the tubing manufacturer's recommended minimum radius.

D. Field Painting:

- 1. Pipe normally exposed to view shall be painted and marked as specified in Section 09900 – Painting
- 2. Outdoor above grade PVC and CPVC piping shall be painted with a UV resistant coating.

3.02 INSPECTION AND TESTING

- A. All PVC and CPVC piping shall be hydrostatically pressure tested and flushed in accordance with the requirements in Section 15014 – Pressure Testing of Piping.
- B. Following installation and testing:
 - 1. Flush clean the carrier and containment piping system.
 - 2. Purge the annular space of moisture with clean, dry air.

3.03 START-UP AND INSTRUCTION

- A. Provide manufacturer's representative to assist with the unloading of the double wall containment piping system, system tests, containment pipe joint closure, installation and testing of the leak detection system, and training of Owner's personnel in the operation and maintenance of the leak detection system. Manufacturer's representative shall complete a Manufacturer's Certificate of Proper Installation. Inspection and examination practices shall be according to ASME B31.3-93 for normal fluid service.

END OF SECTION

SECTION 15080 - MECHANICAL INSULATION

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, tools, equipment, accessories, and services necessary for providing and installing mechanical insulation of all items as shown on Drawings and/or specified herein. All sizing required for preparation of painting shall be performed under this Section.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 15 - Mechanical

1.03 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.04 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulation similar to that required for this project.
- B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
 - 1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
 - 2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

1.05 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section. Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. CONTRACTOR shall furnish ENGINEER for approval a list of insulating materials and thickness for items listed on Schedule. The list shall be complete including all types and thicknesses of insulation used for the various services as well as the limits of Work.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation per Section 01730 – Operations and Maintenance Data. Include this data and product data in maintenance manual.

- D. Provide a schedule of all systems that are to be insulated and or heat traced, indicating all pertinent details for each system, each pipe size, etc.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to Site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from Site.

PART 2 - PRODUCTS

2.01 FOAM INSULATION (For piping smaller than 4" diameter)

- A. Insulation material must be flexible open cell melamine.
- B. Polymeric foam must contain no toxic or carcinogenic materials, produces low out gassing and be fire resistant.
- C. Insulation to have self-sealing adhesive strip along the longitudinal seam.
- D. Insulation must have flexible PVC/fabric composite jacket that is permanently laminated to the foam insulation. Jacket must be UV stabilized; flexible PVC reinforced with polyester fibers.
- E. Color is to be selected by the Owner.
- F. Insulation and jackets must be compatible with heat trace system.
- G. Approved Manufacturers:
 - 1. Techlite Insulation – 379 Series
 - 2. Approved Equal

2.02 PREFORMED THERMAL JACKETS (For piping and valves 4" diameter and larger, including all air release valves)

- A. Approved Manufacturers:
 - 1. ThermaXX LLC 16 Hamilton Street West Haven CT 06516.
 - 2. Approved Equal
- B. Insulation
 - 1. For Box Type Jackets:
 - a. High-temperature insulation blanket formed of silica Aerogel and reinforced with a non-woven, glass-fiber batting.
 - b. Insulation must be hydrophobic.
 - c. Estimation of Maximum Use Temperature 1200°F (650°C)

2. For Non Box Type Jackets:
 - a. Glass mat, type E needled fiber. ¼", ½" @ 9 LB/CF & 1" @ 11.3 LB/CF.
 - b. Estimation of Maximum Use Temperature 1200°F (650°C)
 3. All insulation materials shall be non-Asbestos.
 4. Insulation thickness: As required for Touch Temperature.
- C. Jacket:
1. Color to be selected by the OWNER.
 2. Hot Side
 - a. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
 - b. Estimation of Maximum Use Temperature 550°F (287°C)
 3. Cold Side
 - a. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
 - b. Estimation of Maximum Use Temperature 550°F (287°C)
- D. Thread:
1. Begins to decompose at about 800 degrees (400 degrees C).
 2. Does not melt
 3. Diameter- .0114
 4. Break Point – 35LBS
- E. Insulation and jackets must be compatible with heat trace system.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer. As a minimum the surface to be installed shall be clean, dry and above the ambient air dew point before and during insulation application.

3.02 INSTALLATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor barrier jackets on pipe insulation and protect to prevent puncture or other damage.

- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

3.03 PROCESS PIPING SYSTEM INSULATION

- A. Process piping – Insulate all process piping, exposed to outdoor temperatures, 6-inches and smaller. Provide heat trace where shown on mechanical Drawings. Provide insulation for interior locations where indicated on the Drawings.

3.04 PLUMBING PIPING SYSTEM INSULATION

- A. Cold Piping:
 - 1. Application Requirements: Insulate the following cold plumbing piping systems:
 - a. Potable and Non-Potable cold-water piping.
 - b. Service water piping.
 - c. Plant effluent water piping.
 - d. Interior aboveground stormwater piping.
 - e. Plumbing vents within six lineal feet of roof outlet.
 - 2. Omit insulation of drain piping.
- B. Hot Piping:
 - 1. Application Requirements: Insulate the following hot plumbing piping systems:
 - a. Potable hot water piping.
 - b. Potable hot water recirculating piping.
 - c. Hot drain piping (where indicated).

END OF SECTION

SECTION 15115 - PLUMBING VALVES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General duty valves for pipes 4" and smaller.
- B. Special purpose valves are specified in Section 11243 Chemical Pumps.

1.02 DEFINITIONS

- A. The following abbreviations are used for manufacturers' names listed in this Section:
 - 1. C - Crane
 - 2. J - Jenkins
 - 3. L - Lunkenheimer
 - 4. P - Powell
 - 5. S - Stockham

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section.
 - 1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B31.9, "Building Services Piping."
 - 2. ASME B31.1, "Power Piping."
- B. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.
- C. All valves specified within this section are required to be compatible with the carrier chemical Carus 8700.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves for shipping as follows:
 - 1. Ensure valves are dry and internally protected against rusting and corrosion.
 - 2. Protect valve ends against damage to threads, flange faces, and weld ends preps.
 - 3. Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.
- B. Storage: Use the following precautions during storage:
 - 1. Do not remove valve end protectors, unless necessary for inspection then reinstall for storage.

2. Protect valves from weather; store valves indoors. Maintain valve temperature higher than the ambient dewpoint temperature. If outdoor storage is necessary, support valves off the ground or on pavement in watertight enclosures.
- C. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Crane.
 2. Jenkins.
 3. Lunkenheimer.
 4. Powell.
 5. Stockam.

2.02 VALVE FEATURES

- A. Valve Design: Rising stem or rising outside screw and yoke stems.
1. Nonrising stem valves may be used where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- C. Sizes: Same sizes as upstream pipe, unless otherwise indicated.
- D. Operators: Provide the following special operator features:
1. Handwheels, fastened to valve stem, for valves other than quarter turn.
 2. Lever handles, on quarter-turn valves 6-inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
 3. Chainwheel operators, for valves 2-1/2-inch and larger, install 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
 4. Gear driven operators, on quarter-turn valves 8-inch and larger.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- G. End Connections: As indicated in the valve specifications.
1. Threads: Comply with ANSI B1.20.1.
 2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
 3. Solder-Joint: Comply with ANSI B16.18. Where soldered end connections are used, use solder having a melting point below 840 degrees F for gate, globe, and check valves; below 421 degrees F for ball valves.

BALL VALVES (104)

Subsection Number	Valve Size	Specifications
104.8	1/4" - 2"	PVC, screwed, blow-out proof stem, PTFE seats with O-Rings. Hayward, GF

NOTES: 1. Round or oval handles are available from most manufacturers and should be considered where a valve may be subject to accidental operation or may cause personnel injury.

DIAPHRAGM AND PINCH VALVES (117)

Subsection Number	Valve Size	Specifications
117.3	All	PVC diaphragm valve, union ends, PTFE diaphragm with O-rings. Hayward, GF

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion.
- B. Examine mating flange faces for conditions which might cause leakage. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- C. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.
- D. Replace defective valves with new valves.

3.02 VALVE ENDS SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 1. Steel Pipes Sizes, 2-Inch and Smaller: threaded or grooved end.
 2. Steel Pipe Sizes, 2-1/2-Inch and Larger: grooved end or flanged.
 3. PVC Pipe Sizes, 1/2-inch and larger: solvent welded socket or flanged.

3.03 VALVE INSTALLATIONS

- A. General Application: Ball valves in sizes 2-inch and smaller, and butterfly valves in sizes 2-1/2-inch and larger, are to be used unless gate or globe valves are specifically designated on Drawings. Refer to piping system specification sections for specific valve applications and arrangements.
- B. Locate valves for easy access and provide separate support.
- C. Install valves and unions for each fixture and item of equipment to allow equipment removal without system shut down. Unions are not required on flanged devices.

D. Install valves in horizontal piping with stem at or above the center of the pipe.

E. Install valves in a position to allow full stem movement.

3.04 FIELD QUALITY CONTROL

A. After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.05 ADJUSTING AND CLEANING

A. Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

END OF SECTION

SECTION 15778 - HEAT TRACING FOR 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 piping heat tracing for freeze prevention, with the following electric heating cables:
 - 1. Self-regulating, parallel resistance.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.06 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of delivery.

PART 2 - PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chromalox, Inc.
 - 2. Raychem; Pentair Thermal Management.

- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, nickel-plated, copper bus wires embedded in a self-regulating polymeric core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin or fluoropolymer.
- E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.
- F. Maximum Operating Temperature (Power On): 150° F (65 deg C).
- G. Maximum Exposure Temperature (Power Off): 185° F (85 deg C).
- H. 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.
- I. Capacities and Characteristics:
 - 1. Service: Ø1/2” and Ø1/2” Potable water piping
 - a. Start-up Temperature: 0° F
 - b. Maintain Temperature of 40° F
 - c. Maximum Heat Output: 5 W/ft.
 - d. Minimum Insulation Thickness: 1” Electrical Characteristics for Single-Circuit Connection:
 - Volts: 120.
 - Phase: 1.
 - Hertz: 60.
 - 2. Service: Ø1/2” Chemical Process piping in a 2” Containment piping
 - a. Start-up Temperature: 0° F
 - b. Maintain Temperature of 40° F
 - c. Maximum Heat Output: 10 W/ft.
 - d. Minimum Insulation Thickness: 1”
 - e. Electrical Characteristics for Single-Circuit Connection:
 - Volts: 120.
 - Phase: 1.
 - Hertz: 60.

2.02 CONTROLS

- A. Pipe-Mounted Thermostats for Freeze Protection:
 - 1. Remote bulb unit with adjustable temperature range from 23° to 60° F (minus 1 to plus 10 deg C).
 - 2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
 - 3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
 - 4. Corrosion-resistant, waterproof control enclosure.
 - 5. Suitable for Class 1, Division 1 locations.

6. Explosion proof construction.
7. Alarm contacts for fault status.

2.03 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inch (19 mm)es minimum.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Electric Heating-Cable Installation for Freeze Protection for Piping:
 1. Install electric heating cables after piping has been tested and before insulation is installed.
 2. Install electric heating cables according to IEEE 515.1.
 3. Install insulation over piping with electric cables according to Section 15080 "Mechanical Insulation."
 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- B. Set field-adjustable switches and circuit-breaker trip ranges.
- C. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

3.03 CONNECTIONS

- A. Connect wiring according to Section 16120 "Wires and Cables."
- B. Ground equipment according to Section 16060 "Grounding."

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 2. Test cables for electrical continuity and insulation integrity before energizing.
 - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 PROTECTION

- A. Protect installed heating cables, including nonheating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

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 on tracing cloth, Mylar, or sepia paper from which blueprints can be obtained.
- 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. Coordinate with telephone company the communication service requirements. Furnish, install, and connect cable and terminal equipment not furnished, installed, or connected by telephone company. Furnish and install a 4-foot by 8-foot by 3/4-inch plywood backboard painted white, raceway from backboard to property line, and cross-connect base and blocks which utilize punchdown wiring methodology.
- E. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- F. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- G. 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.
- H. 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.
- I. 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.
- J. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.
- K. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- L. Install access panel or doors where units are concealed behind finished surfaces.
- M. 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 Direct Buried Conduit: PVC externally coated rigid metal conduit.
 3. Underground Concrete Encased Conduit: Fiberglass-reinforced conduit or rigid nonmetallic conduit if the conductors are used for power or 120 VAC; otherwise, use rigid metal conduit.
 4. 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.
 - a. Exception: NEMA 7 or 9 areas require explosion-proof flexible 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.
 - 2) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid steel 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 conduits enter or leave hazardous locations.
 - 2. Where conduits enter or leave NEMA 4X areas.
 - 3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
 - 4. 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 and telephone jacks, 18 inches except in NEMA 4 and 4X areas, 4 feet.

- 3. Thermostats, 4'-0".
 - 4. Clock receptacles, 7'-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.
 - 1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.
- 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 01730. 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:

$$R_{\min.} = 4 (KV + 1) \text{ at } 25 \text{ degrees C winding temp.}$$

$$R_{\min.} = IV + 1 \text{ at } 40 \text{ degrees C winding temp.}$$

- 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 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. Underground metal structures.
 - 4. Metal building frames.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.
 - 12. Lighting standards.
 - 13. Landscape lighting.
 - 14. 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: 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. Ground Bus: 0.25 inch by 1-inch minimum copper ground bus where indicated.
4. Service Arrester: Electrical service arrester, 480 volts, 3-phase, 4-wire, for exterior mounting.
5. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 20 feet.
6. 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 exothermic weld process or 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.
- B. Test ground paths for continuity by applying a low DC voltage source of current, capable of furnishing up to 100 amps, between electrical equipment grounds and ground grid. Grounding path must conduct a 100-amp current at a resistance of 0.010 ohms or less as calculated from circuit voltage.

END OF SECTION

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 stainless steel. Products for use outdoors, in NEMA 4 areas, or embedded in concrete or in Nema 12 areas indoors shall be stainless steel.

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 stainless steel spring clamps.
- B. Fasteners. Types, materials, and construction features as follows:
 - 1. Expansion Anchors: 304 stainless steel wedge or sleeve type.
 - 2. Toggle Bolts: 304 stainless steel springhead type.
 - 3. Hanger Rods: 0.375-inch diameter minimum, 304 stainless 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 304 stainless steel.
- E. U-Channel Systems: 12 gauge or 0.105-inch-thick 304 stainless 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. 304 stainless 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. Steel Pipe: Fabricate from Schedule 40 stainless steel pipe.
 - 2. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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. Operational instruction signs.
 - 4. Warning and caution signs.
 - 5. 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. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- B. 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.
- C. 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.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.
- E. 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.
- F. 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 white letters on black face and punched for mechanical fasteners.
- G. 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.

- H. 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.
- I. 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.
- J. 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. Wiring Standards:
 - 1. 480/277 Volt, 3-Phase Power:
 - a. Brown.
 - b. Orange.
 - c. Yellow.
 - d. Grey Neutral.
 - 2. 208 Volt, 3-Phase Power:
 - a. Black.
 - b. Red.
 - c. Blue.
 - 3. 240/120 Volt, 1-Phase Power:

- a. Black.
- b. Red.
- c. White Neutral.
- 4. Motor Leads, Control Cabinet/MCC:
 - a. Black, numbered L1-T1, etc.
- 5. Control Wiring:
 - a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
 - b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
 - c. Blue DC.
 - d. Green Ground.
- F. 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.
- G. 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.
- H. 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

SECTION 16090 - DEMOLITION AND EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Limited scope general construction materials and methods for application with electrical installations as follows:
 - 1. Selective Demolition including:
 - a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
 - b. Dismantling electrical materials and equipment made obsolete by these installations.
 - 2. Excavation for underground utilities and services, including underground raceways, vaults, and equipment.

1.02 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following Project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Conditions Affecting Excavations: The following Project conditions apply:
 - 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 - 3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. OWNER will not be responsible for interpretations or conclusions drawn from this information.
 - 4. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
 - 5. Remove existing underground utilities indicated to be removed.
 - a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
 - b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to ENGINEER prior to utility interruption.
 - 6. Use of explosives is not permitted.

1.03 SEQUENCING AND SCHEDULING

- A. Coordinate the shutoff and disconnection of electrical service with OWNER and utility company.
- B. Notify ENGINEER at least 5 days prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SELECTIVE DEMOLITION

- A. Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to location designated for storage.
- C. Disposal and Clean Up: Remove from Site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- D. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete raceway systems, controls, and fixtures.
 - 2. Raceways embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings.
- E. Perform cutting and patching required for demolition in accordance with Section 01730.

3.02 EXCAVATION

- A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
- B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
- C. Remove and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
- D. Install sediment and erosion control measures in accordance with local codes and ordinances.
- E. Dewatering: Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding Project Site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- F. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retail soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- G. Excavation for Underground Vaults and Electrical Structures: Conform to elevations and dimensions shown 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, other construction, and for inspection.
1. Excavate, by hand, areas within drip line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- H. Trenching: Excavate trenches for electrical installations as follows:
1. Excavate trenches to uniform width, sufficiently wide to provide ample working room and minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
 2. Excavate trenches to depth indicated or required.
 3. Limit length of open trench to that in which installations can be made and trench backfilled within same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
- I. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F (1 degree C).
- J. Backfilling and Filling. Place soil materials in layers to required subgrade elevations for each area classification listed below:
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceway less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation of raceways, provide a 4-inch-thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas, use excavated or borrowed materials.
- K. Backfill excavations as promptly as work permits, but not until completion of following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- L. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- M. 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 specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

- N. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- O. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact to 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during or subsequent to compaction operations.
- P. Subsidence. Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

END OF SECTION

SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Low-Voltage Wire and Cable.
 - 2. Medium-Voltage Cable.
 - 3. Instrument Cable.
 - 4. 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.
 - 2. NEMA WC 71-1999/ICEA S-96-659-1999, Standard for Nonshielded Cables Rated 2,001-5,000 Volts for use in the Distribution of Electrical Energy.
 - 3. NEMA WC 74-2000/ICEA S-93-639, 5-46 kV Shielded Power Cable for use in the Transmission and 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. Medium-Voltage Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. Kerite Co.
 - d. The Okonite Co.
 - e. Prysmian Cables & Systems.
 - f. Southwire Co.
 - 4. Medium-Voltage Cable Splicing and Terminating Products and Accessories:
 - a. Adelet-PLM.
 - b. Amerace Corp.
 - c. Electrical Products Division 3M.
 - d. G&W Electric Co.
 - e. M.P. Husky Corp.
 - f. Raychem Corp.
 - g. RTE Components.
 - 5. Instrument Cable:
 - a. Belden (Trade Nos. 1120A and 1118A).
 - 6. 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 single- and 3-phase circuits with more than 120 volts to ground. Provide RHW/USE, XHHW, or THWN/THHN insulation for power conductors used in single- and 3-phase circuits with 120 volts or less to ground
 1. Provide RHW, THHN/THWN, or 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 MEDIUM-VOLTAGE CABLE

- A. Cable shall be single-conductor type, size as indicated, and conforming to UL Standard 1072, "Medium Voltage Power Cables."
- B. Cable shall be ethylene propylene rubber (EPR) insulated and shall conform to NEMA Standard WC 74-2000 (ICEA S-93-639) "5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electrical Energy."
- C. Conductors: Class B stranded, annealed copper.
- D. Conductor Shield: Extruded, semiconducting.
- E. Insulation Shield: Extruded, semiconducting.
- F. Concentric Neutral: Evenly spaced, annealed, coated, solid copper wires applied concentrically over semiconducting insulation shield. Individual wires shall be No. 14 AWG minimum. Concentric neutral ampacity shall be not less than 1/3 the ampacity of central conductor.
- G. Metallic Shielding: Copper shielding tape, helically applied over semiconducting insulation shield or evenly spaced solid copper wires applied concentrically over semiconducting insulation shield.
- H. Cable Jacket: Sunlight-resistant PVC, cross-linked polyolefin, or chlorosulfonated polyethylene (hypalon).
- I. Cable Voltage Rating: 5 kV phase to phase.
- J. Cable Voltage Rating: 8 kV phase to phase.

- K. Cable Voltage Rating: 15 kV phase to phase.
- L. Cable Voltage Rating: 25 kV phase to phase.
- M. Cable Voltage Rating: 28 kV phase to phase.
- N. Cable Voltage Rating: 35 kV phase to phase.
- O. Cable Voltage Rating: 46 kV phase to phase.

2.05 MEDIUM-VOLTAGE SPLICING AND TERMINATING PRODUCTS

- A. Types: Compatible with cable materials and shall be suitable for indoor or outdoor environments as required.
- B. Connectors: Compression type as recommended by cable or splicing kit manufacturer for application.
- C. Splicing and Terminating Kits: As recommended by manufacturer in writing for specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain components required for a complete splice or termination including detailed instructions and shall be the product of a single manufacturer. Completed splices and terminations shall provide insulation equivalent to the insulation class of cable it connects and maintain current carrying capacity and mechanical strength of cable.

2.06 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.

2.07 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. Medium-Voltage Cable Tests shall include high-potential test of cable and accessories and such tests and examinations required to achieve specified objectives. Where new cables are spliced to existing cables, high-potential test shall be performed on the new cable prior to splicing. After test results for new cables are approved and splice is made, an insulation resistance test and continuity test on the length of cable including the splice with existing cables being tested to the nearest disconnect point.
- C. 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.
- D. 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. Flexible metal conduit.
 2. Intermediate metal conduit.
 3. Liquidtight flexible conduit.
 4. Underground plastic utilities duct.
 5. Rigid metal conduit.
 6. Rigid nonmetallic conduit.
 7. Surface raceways.
 8. PVC externally coated rigid metal conduit.
 9. Fiberglass reinforced conduit.
 10. Electrical nonmetallic tubing.
 11. Wireway.
 12. 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. Surface raceway and fittings.
 - b. Wireway and fittings.
 - c. Conduit.
 - d. 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. Johns Manville.
 - d. Occidental Coatings.
 - e. Orangeburg.
 - f. Perma-Cote Industries.
 - g. Republic Steel.
 - h. Steelduct Co.
 - i. Triangle Conduit.
 - j. Wheatland Tube.
 - k. 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. Spring City Electrical Mfg. Co.
 4. Conduit Thread Paint:
 - a. CRC Chemicals, USA.
 - b. Sherwin Williams.
 - c. ZRC Chemical Products Co.
 5. Wireway:
 - a. Alrey-Thompson Co.
 - b. Anchor Electric Co.
 - c. Hoffman Engineering Co.
 - d. Keystone/Rees, Inc.
 - e. Robroy Industries, Inc.
 - f. Square D Company.
 6. Surface Metal Raceway:
 - a. Allied Tube & Conduit.
 - b. B-Line Systems, Inc.
 - c. Butler Mfg. Co.
 - d. Hoffman Engineering Co.
 - e. Isoduct Energy Systems.
 - f. Isotrol Systems.
 - g. Keystone/Rees, Inc.
 - h. Square D Company.
 - i. The Wiremold Co.
 7. Surface Nonmetallic Raceway:
 - a. Anixter Brothers, Inc.
 - b. Hoffman Engineering Co.
 - c. Hubbell, Inc.

- d. Panduit Corp.
- e. Premier Telecom Products, Inc.
- f. Thermotools Co.
- g. The Wiremold Co.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Metal Conduit: ANSI C 80.1, hot-dip galvanized.
- B. 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.
- C. Flexible Metal Conduit: UL 1, zinc-coated metal.
- 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 and ABS Plastic Utilities Duct: NEMA TC 6, Type I for encased burial in concrete, Type II for direct burial.
- D. PVC and ABS Plastic Utilities Duct Fittings: NEMA TC 9; match to duct type and material.
- E. Liquidtight Flexible Nonmetallic Conduit and Fittings: UL 1660. Fittings shall be specifically approved for use with this raceway.
- F. Fiberglass-Reinforced Conduit and Fittings: CSA B196.1 and B1089 A.

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. Electrical Metallic Tubing: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and compression type or setscrew connectors.
 - 4. 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.

5. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.
6. NEMA 7 and NEMA 9 Areas: Use materials conforming to UL standards for the area.

2.05 WIREWAYS

- A. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.
- B. Wireway covers shall be hinged type.

2.06 SURFACE RACEWAYS

- A. Sizes and channels as indicated. Provide fittings that match and mate with raceway.
- B. Surface Metal Raceway: Construct of galvanized steel with snap-on covers, with 1/8-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required.
- C. Surface Nonmetallic Raceway: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color. Raceway and system components shall meet UL 94 requirements for nonflammable, self-extinguishing characteristics.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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. Terminal boxes.
 4. Bushings.
 5. Locknuts.
 6. 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 JB, GS, or SHE.
 - b. Crouse-Hinds, Type GS or GRF.
- 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. Terminal Boxes:
 - a. AMFCO.
 - b. Boss.
 - c. Hoffman.
 - d. Keystone.
 - e. Hope.
- 8. 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 outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 12 and 4 areas 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 provide 316 stainless steel hinged boxes. Provide exterior mounting lugs. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. 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 316 stainless 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. Terminal Boxes: Provide compression lug type terminal strips in each terminal box with a minimum of 20 percent spare terminals. Provide appropriate NEMA enclosure rating for area in which terminal box is installed.
- E. 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. Plugs.
 - 4. Plug connectors.
 - 5. Telephone and network outlets.
 - 6. 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. Receptacles, Industrial Heavy-Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.

- D. 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.
- E. Plugs: 15 amperes, 125 volts, 3-wire, grounding, armored cap plugs, parallel blades with cord clamp, and 0.4-inch cord hole; match NEMA configuration with power sources.
- F. Plug Connectors: 15 amperes, 125 volts, bakelite-body armored connectors, 3-wire, grounding, parallel blades, double wipe contact, with cord clamp, and 0.4-inch cord hole, match NEMA configuration to mating plugs. Arrange as indicated.
- G. Telephone and Network Outlets: Telephone outlets shall consist of box, wall plate, and RJ-12 jack. Network outlets shall consist of box, wall plate, and RJ-45 jack. Network outlet shall comply with requirements of CAT-5E cabling systems. Wall plates shall match color and style of receptacle and switch wall plates used throughout the Project.

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.
 - 4. NEMA 7 and NEMA 9 Material and Finish: cast metal cover plates meeting NEC requirements for area.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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 (no or equal):
 - 1. Allen-Bradley.
 - 2. 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. Circuit Breaker Switches: Where individual circuit breakers are required, provide 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 C. Provide with AL/CU-rated mechanical screw type removable connector lugs.

- D. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.
- E. Double-Throw Switches: (Heavy-duty) switches of classes and current ratings as indicated.
- F. Bolted Pressure Switches: Bolted pressure switches conforming to and listed under UL Standard 977, single- or double-throw arrangement as indicated. For fusible units, provide fuses as indicated.
- G. Service Switches: (Heavy-duty) fusible/circuit breaker switches. UL listed for use as service equipment under UL Standard 98 or 869.
- H. Switches for Classified (Hazardous) Locations: Heavy-duty switches with UL labels and listings for hazardous location classifications in which installed.

2.03 ACCESSORIES

- A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 - 1. Stainless Steel for NEMA 12 and NEMA 4 switches.
 - 2. Molded fiberglass-reinforced plastic for NEMA 4X 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. Solid-state reduced voltage controllers.
 3. 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 (no or equal):
1. Allen-Bradley Co.
 2. 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.
 - b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.
 - c. Two-speed (for two winding motor): Two, 3-pole magnetic contactors, each with its own set of 3 overload devices.
 - d. Two-speed (for single winding motor): Two magnetic contactors, a 5-pole for high speed, and a 3-pole for low speed, each with its own set of 3 overload devices.
 - e. Reduced Voltage (for wye-connected part winding motors): Two 3-pole magnetic contactors, each with its own set of 3 overload devices and a timer for closing of the running contactor. Running contactor shall be sized for motor full load current, and starting (half-winding) contactor shall be sized for at least 75 percent of the full load current and shall be capable of interrupting at least 10 times full load current.
 - f. Reduced Voltage (closed transition autotransformer type): Three magnetic contactors, two 2-pole and one 3-pole with a common set of 3 overloads, a timing relay and an autotransformer with taps at 50, 65, 80, and 100 percent, and an integral temperature switch or timing relay to protect transformer windings.

- C. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in the transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of the unit requirements or provide 150VA rated transformer, whichever is greater. Provide 300 volt rated, oiltight type pilot lights, push buttons with extended guard and black color insert. Equip stop push buttons with half guard and red color insert. Provide 120/6 volt transformer type push-to-test pilot lights with lens color indicated. Provide machine tool type relays, each with 1 spare N.O. contact. Provide 6-digit elapsed time indicators with one-tenth hour increments. When timers are required, they shall be synchronous type.

- D. 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