INVITATION TO BID
No. 202004

PENNSYLVANIA AVENUE AND CONWAY WASTEWATER PUMP STATIONS REPLACEMENT

FOR THE

DEPARTMENT OF PUBLIC SERVICES

Project Manual

Contract Documents

Specifications

February 2020

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PENNSYLVANIA AVENUE AND CONWAY WASTEWATER PUMP STATIONS REPLACEMENT

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City of Winchester
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INVITATION TO BID

Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

ITB # 202004

The City of Winchester is submitting this Invitation to Bid to establish a contract with qualified Contractors furnishing all labor, equipment, transportation and materials necessary for the following project:

Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

Project includes furnishing and installing new Pennsylvania Avenue and Conway wastewater pump stations and demolition of existing facilities. The new pump stations are submersible style pump stations including wet wells, valve vaults and prefabricated electrical buildings, new potable water service, new emergency generators and fuel tanks, existing gravity sewer modifications, new manholes, related site work and associated electrical and controls.

A **mandatory** pre-bid meeting will be held on **March 3, 2020 at 2:00pm** in the 4th floor Exhibit Hall of Rouss City Hall, 15 N. Cameron Street, Winchester, VA 22601. Due to the importance of all respondents having a clear understanding of the specifications/scope of work and requirements of this solicitation, attendance at this conference will be a prerequisite for submitting a proposal. Proposals will only be accepted from those respondents who are represented at this pre-bid meeting. Attendance at the meeting will be evidenced by the representative's signature on the attendance roster. No one will be admitted after 2:05 P.M. (local time).

Contract Specifications may be obtained from the below address and all bids shall be received at:

City of Winchester, Virginia
Finance Department - Purchasing Division
Rouss City Hall, 1st Floor – Room 106
15 North Cameron Street
Winchester, Virginia 22601
Telephone (540) 667-2378

The contract documents and drawings may be downloaded at no cost from the City's website at:
http://www.winchesterva.gov/purchasing/itbrfp.php

Any questions regarding the contract documents or drawings shall be sent **in writing via e-mail** to:

Kelly Henshaw: kelly.henshaw@winchesterva.gov

Bid prices shall be made on the blank Bid Form provided herein. Bids shall be delivered to the above address on or before **2:00 p.m. (local time) on March 19, 2020,** at which time the bids shall be publicly read aloud.

Bids will be received only from contractors with a valid Contractor license in the Commonwealth of Virginia. **Bidders shall indicate on the outside of the envelope containing the Bid their current Virginia Contractor's Registration Number. Bids without this information on the outside of the envelope may be considered**

non-responsive.

Each Bid shall be accompanied by complete response to the Contractor Qualification Data Sheet. The successful bidder shall meet the minimum qualifications specified in the Contractor Qualification Data Sheet. A bid from a bidder that does not meet the minimum qualifications specified in the Contractor Qualification Data Sheet, as determined by the City, shall be non-responsive.

Each Bid shall also be accompanied by a satisfactory Bid Guarantee in the amount of 5% of the bid, in the form of a certified or cashier's check drawn on a bank chartered under the laws of the Commonwealth of Virginia; payable to the Treasurer of the City of Winchester, or a Bid Bond, as a guarantee that the bidder will within fifteen (15) days after the date of the award of the Contract, execute an agreement and file insurance as required by the Contract Documents if his proposal is accepted. If the successful bidder fails to execute and file the agreement and insurance, the amount of the Bid Guarantee shall be forfeited. Bids without a satisfactory Bid Guarantee shall be rejected.

Performance and Payment Bonds will be required of the successful bidder, each in an amount equal to one hundred (100) percent of the amount of the Contract, conditioned upon the faithful performance of the Contract and to the payment in full to all persons furnishing labor, materials, equipment, etc., for and in connection with the work to be performed under the contract.

Bidder desiring to withdraw his bid after the bid opening procedure, shall give notice in writing of his claim of right to withdraw his bid within two (2) business days after the conclusion of the bid opening procedure. Bidder shall submit to the City his original work papers; documents and materials used in preparation of the bid sought to be withdrawn. Bidder withdrawing his bid that does not meet these requirements shall forfeit their bid bond.

The City of Winchester reserves the right to reject any proposal for failure to comply with all requirements of this notice or any of the Contract Documents; however, it may waive any minor defects or informalities at its discretion. The City further reserves the right to reject any and all proposals, cancel the ITB at any time prior to award or to award a contract that in its judgment is in the best interest of the City.

CITY OF WINCHESTER, VIRGINIA

BY: Mike Marzullo, Purchasing Agent

Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

INSTRUCTIONS TO BIDDERS

1. **OWNER AND ENGINEER:**

The Owner is the City of Winchester Department of Public Services, which shall be represented by the City Engineer or his designee who shall perform the duties of the Engineer. Telephone: Department of Public Services, (540) 667-1815, extension 1481.

2. **COPIES OF CONTRACT DOCUMENTS:**

2.01 Bidding Documents may be examined and downloaded from the City's website at http://www.winchesterva.gov/purchasing/itbrfp at no charge.

City of Winchester, Virginia
Finance Department - Purchasing Division
Rouss City Hall, 1st Floor – Room 106
15 North Cameron Street
Winchester, Virginia 22601
Telephone: (540) 667-2378

2.02 Complete set of Bidding Documents shall be used in preparing bids; neither the Owner nor the Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents. Owner and Engineer in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining bids on the Work and do not confer a license or grant for any other use.

3. **EXAMINATION OF CONTRACT DOCUMENTS AND SITE:**

3.01 Before submitting a bid, each bidder must examine the Contract Documents thoroughly, visit the site to familiarize himself with local conditions that may in any manner affect cost, progress, or performance of the work, familiarize himself with federal, state, and local laws, ordinances, rules, and regulations that may in any manner affect cost, progress, or performance of the work; and study and carefully correlate bidder's observations with the Contract Documents.

3.02 Before submitting his bid, each bidder will, at his own expense, make such additional investigations and tests as the bidder may deem necessary to determine his bid for performance of the work in accordance with time and other terms and conditions of the Contract Documents. The Contractor shall be responsible for taking his own borings or

making any investigations he requires to establish subsurface conditions in the area of this Contract. The City does not assume any responsibility for the subsurface conditions which may be encountered. On request, Owner will provide each bidder access to the site to conduct such investigations.

3.03 The submission of a bid will constitute an incontrovertible representation by the bidder that he has examined the site and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions of the Work.

3.04 It is understood and agreed by the bidder that the estimate of quantities (if provided) are approximate, and are presented in order to obtain unit prices and approximate amount of the Contract. The Contractor shall make no claim against the City because of any estimate, tests or representations made by any officer or agent of the City, which may prove to be in any respect erroneous.

3.05 Scope of the work is as specified herein. The Owner, however, reserves the right to make adjustments to the scope of the work. Such adjustments shall be accomplished by appropriate Change Orders.

4. SPECIFICATIONS:

The technical specifications for the project are provided within this contract document.

5. INTERPRETATIONS:

All questions about the discrepancies or ambiguities in the Contract Documents prior to the bid opening shall be submitted in writing via e-mail to the following:

Kelly Henshaw, City Engineer: kelly.henshaw@winchesterva.gov

Replies to questions will be issued by Addenda mailed or delivered to all parties recorded by the Purchasing Agent as having received the Bidding Documents or by posting on a Question and Answer Bulletin Board posted at the following location:

http://www.winchesterva.gov/purchasing/itbrfp

Questions received less than five (5) calendar days prior to the date for opening of bids may not be answered. Only questions answered by formal written Addenda or in writing on the Question and Answer Bulletin Board will be binding.

6. REQUIRED BOND - BID GUARANTEE:

6.01 Bid Guarantee shall be made payable to Owner, in an amount of five percent (5%) of the bidder's maximum bid price and in a form of a certified or cashier's check drawn on a bank chartered under the laws of the Commonwealth of Virginia; payable to the Treasurer, City of Winchester, or a Bid Bond issued by a surety having registered resident agents in Virginia.

6.02 The Bid Guarantee of the successful bidder will be retained until such bidder has executed the Agreement and furnished the required Contract Security, whereupon it will be returned. If the successful bidder fails to execute the agreement and furnish the required Contract Security within fifteen (15) calendar days of the Notice of Award, Owner may annul Notice of Award and the Bid Guarantee of the bidder will be forfeited.

7. **REQUIRED BONDS – PAYMENT AND PERFORMANCE:**

Performance and Payment Bonds will be required of the Successful bidder, each in an amount equal to one hundred percent (100%) of the amount of the Contract, conditioned upon the faithful performance of the Contract and to the payment in full to all persons furnishing labor, materials, equipment, etc., for and in connection with the work to be performed under the Contract.

8. **CONTRACT TIME:**

Contractor agrees that all work shall be completed within **365 calendar days** following the Notice to Proceed.

Owner and Contractor recognize that the time is of essence in this Contract, and if the work is not completed within the specified times outlined above, plus any extensions allowed, then the Contractor shall pay, as liquidated damages, $1,000.00 for each calendar day that expires after the specified completion date.

9. **PAYMENT PROCEDURE:**

9.01 The basis for payment shall be the actual percentage of work completed, as determined in the field by the Engineer.

9.02 An amount equal to five percent (5%) of each progress payment shall be held from each payment as retainage.

10. **SUBCONTRACTORS:**

10.01 The apparent successful bidder and any other bidder so requested, will within seven (7) days after the day of bid opening submit to Owner a list of all subcontractors and other

persons and organizations, including those who are to furnish the principal items of material and equipment, proposed for the work. Such list shall be accompanied by an experience statement with pertinent information as to similar projects and other evidence of qualification for each such subcontractor, person, and organization. If Owner or Engineer, after due investigation has reasonable objection to any proposed subcontractor, other person or organization, either may before giving the Notice of Award request the apparent successful bidder to submit an acceptable substitute without an increase in Bid price. If the apparent successful bidder declines to make any such substitution, the Contract shall not be awarded to such bidder, but his declining to make any such substitution will not constitute grounds for sacrificing his Bid Bond. Any subcontractor, other person, or organization so listed and to whom Owner or Engineer does not make written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer.

10.02 No Contractor shall be required to employ any subcontractor, other person, or organization against whom he has reasonable objection.

11. SUBSTITUTE MATERIAL AND EQUIPMENT

11.01 Whenever it is indicated in the Contract Documents that a substitute or "or equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered until after the Effective Date of the Contract Agreement. The procedure for submittal of any such application by Contractor and consideration by Engineer is set forth in the General Conditions.

12. PREPARATION OF BID:

12.01 The Bid Form is included in these Specifications, and may not be altered in any way. Additional copies may be obtained from the City of Winchester.

12.02 Bid Forms must be completed in ink or by typewriter. The Total Base Bid price must be stated in words and numerals; in case of conflict, words will take precedence.

12.03 A. Bids MUST give full firm name and address of bidder. Failure to manually sign bid may disqualify it. Person signing bid will show TITLE or AUTHORITY TO BIND THE FIRM IN A CONTRACT. Firm name and authorized signature must appear on bid in the space provided on the bid form. Those authorized to sign are as follows:

If a sole proprietorship, the owner may sign.
If a general partnership, any general partner may sign.
If a limited partnership, a general partner must sign.
If a limited liability company, a “member” may sign or a “manager” must sign if so

specified by the articles or organization.
If a regular corporation, the CEO, President or Vice-President must sign.
Others may be granted authority to sign but the City requires that a corporate document authorizing him/her to sign be submitted with bid.

B. Contractor's license or registration number shall be entered in the space provided on the Bid Form.

C. A bidder or offeror organized or authorized to transact business in the Commonwealth pursuant to Title 13.1 or Title 50 of the Code of Virginia shall include in its bid or proposal the identification number issued to it by the State Corporation Commission (SCC). Any bidder or offeror that is not required to be authorized to transact business in the Commonwealth as a foreign business entity under Title 13.1 or Title 50 of the Code of Virginia or as otherwise required by law shall include in its bid or proposal a statement describing why the bidder or offeror is not required to be so authorized. Any bidder or offeror described herein that fails to provide the required information may not receive an award unless a waiver of this requirement and the administrative policies and procedures established to implement this section is granted by the City Manager. The SCC may be reached at (804) 371-9733 or at http://www.scc.virginia.gov/default.aspx.

12.04 Bidder shall make acknowledgement on the Bid Form of receipt of all Addenda, the numbers of which shall be filled in the Bid Form.

SUBMISSION OF BIDS:

13.01 Bids shall be submitted at the time and place indicated in the Invitation to Bid and shall be included in an opaque sealed envelope, along with the Bid Bond, Non-collusion Affidavit, and other required documents. The sealed envelope shall indicate the Project Title, name and address of the bidder, and State Registration No. of the bidder. If the bid is sent through the mail, or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation **"BID ENCLOSED"** on the face thereof.

13.02 Timely delivery of the Bid shall be the sole responsibility of the Bidder. Bids must be received not later than the time and date stated in the Invitation to Bid. Bids by telephone, facsimile or other forms shall not be accepted.

14. **MODIFICATION AND WITHDRAWAL OF BIDS:**

14.01 Bids may be modified or withdrawn by an appropriate document duly executed (in the manner that a bid must be executed) and delivered to the place where bids are to be submitted at any time prior to opening of the bids. The request for withdrawal or

modification must be in writing and signed by a person duly authorized to do so.

14.02 No bidder may withdraw his bid within thirty (30) calendar days after the actual date of the bid opening, except as allowed by the Code of the City of Winchester, Virginia, Section 21-43(a), which states "the Bidder shall give notice in writing of his claim of rights to withdraw this bid within two (2) business days after the conclusion of the bid opening procedure". Bidder shall submit to the Owner his original work papers, documents and materials used in preparation of his bid sought to be withdrawn.

15. **OPENING OF BIDS:**

15.01 Bids shall be opened publicly, and will be read aloud at the time and location indicated on the Invitation to Bid. An abstract of the amounts of the Bids shall be made available after the opening of bids.

15.02 All bids shall remain open for sixty (60) days after the day of the bid opening, but Owner may, in his sole discretion, release any bid and return the Bid Bond prior to that date.

AWARD OF CONTRACT:

15.03 Owner reserves the right to reject any and all bids, to waive any and all informalities and to negotiate Contract terms with the successful bidder, and the right to disregard all nonconforming, nonresponsive, or conditional bids. Discrepancies between words and figures shall be resolved in favor of words. Discrepancies between indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

15.04 In evaluating bids, Owner will consider the qualifications of the bidders, whether or not the bids comply with the prescribed requirements, and alternates and unit prices if requested in the Bid Form. Owner may consider the qualifications and experience of subcontractors and other persons and organizations proposed for the work.

15.05 Owner may conduct such investigations as he deems necessary to assist in the evaluation of any bid and to establish the responsibility, qualifications, and financial ability of the bidders, proposed subcontractors and other persons and organizations, to do the work in accordance with the Contract Documents and to the Owner's satisfaction within the prescribed time.

15.06 Owner reserves the right to reject the bid of any bidder who does not pass any such evaluations to Owner's satisfaction.

15.07 If the Contract is to be awarded, it will be awarded on a Base Bid price basis to the lowest responsive and responsible bidder, and whose evaluation by the Owner indicates that

the award will be in the best interest of the Project and the City. Discounts for prompt payment, liquidated damages, and cash incentives will not be part of the award.

16. **NEGOTIATION WITH THE LOWEST BIDDER**:

Unless all bids are cancelled or rejected, the City of Winchester reserves the right granted by § 2.2-4318 of the *Code of Virginia* to negotiate with the lowest responsive, responsible bidder to obtain a contract price within the funds available to the agency whenever such low bid exceeds the agency's available funds. For the purpose of determining when such negotiations may take place, the term "available funds" shall mean those funds which were budgeted by the agency for this contract prior to the issuance of the written Invitation for Bids. Negotiations with the low bidder may include both modifications of the bid price and the Scope of Work/Specifications to be performed. The agency shall initiate such negotiations by written notice to the lowest responsive, responsible bidder that its bid exceeds the available funds and that the agency wishes to negotiate a lower contract price. The times, places, and manner of negotiating shall be agreed to by the agency and the lowest responsive, responsible bidder.

17. **SIGNING OF CONTRACT:**

Owner shall give Notice of Award to the successful bidder accompanied by at least three (3) unsigned counterparts of the Contract and all other Contract Documents. Within fifteen (15) days thereafter, Contractor shall sign and deliver at least three (3) counterparts of the Contract to the Owner with all other Contract Documents attached. Within ten (10) days thereafter, Owner will deliver all fully signed counterparts to Contractor. Engineer will identify those portions of the Contract Documents not fully signed by Owner and Contractor and shall ensure that all parties appropriately execute all required portions of the contract immediately.

- END OF SECTION -

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BID FORM
Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement
ITB# 202004

This Bid is submitted to:

City of Winchester, Virginia
Finance Department - Purchasing Division
Rouss City Hall, 1st Floor
15 North Cameron Street
Winchester, Virginia 22601

In submitting this Bid, bidder acknowledges that the bidder has examined copies of the following Contract Documents:

BIDDING DOCUMENTS

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- Instructions to Bidders
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	11100	Pumps - General
	11142	Submersible Chopper Pumps
15		MECHANICAL
	15000	Basic Mechanical Requirements
	15006	Ductile Iron Pipe
	15008	PVC Pipe
	15020	Pipe Supports
	15095	Valves - General
	15105	Check Valves
	15107	Yard Hydrants
	15108	Gate Values
	15109	Plug Valves
	15390	Schedules
	15400	Plumbing
	15500	Basic HVAC Requirements
	15598	Ductwork and Duct Accessories
	15750	Packaged Air Conditioning Units
	15990	Testing, Adjusting, and Balancing
16		ELECTRICAL
	16000	Basic Electrical Requirements
	16055	Power System Studies
	16111	Conduit
	16123	Low Voltage Wire and Cable
	16130	Boxes
	16141	Wiring Devices

	16170	Grounding and Bonding
	16190	Supporting Devices
	16195	Electrical - Identification
	16440	Disconnect Switches
	16470	Panelboards
	16476	Enclosed Circuit Breakers
	16481	Individual Motor Controllers
	16495	Variable Frequency Drive Systems
	16496	Automatic Transfer Switch
	16500	Lighting
	16620	Packaged Generator System
	16902	Electrical Controls and Relays
17		CONTROL AND INFORMATION SYSTEMS
	17000	Control and Information System Scope and General Requirements
	17030	Control and Information System Submittals
	17050	Tools, Supplies, and Spare Parts - General
	17060	Signal Coordination Requirements
	17070	Control and Information System Testing - General
	17071	Factory Acceptance Test
	17072	Field Testing
	17080	Quality Assurance
	17100	Control and Information System Hardware - General
	17120	Programmable Logic Controllers
	17125	Operator Interface Terminals
	17180	Process Control System Networks
	17190	Uninterruptible Power Systems
	17200	Control and Information System Software Requirements
	17500	Enclosures - General
	17510	Cabinets and Panels
	17550	Panel Instruments and Accessories
	17560	Surge Protection Devices
	17600	Instruments - General
	17650	Pressure Gauges
	17670	Level Switches
	17698	Instrumentation and Control System Accessories
	17701	Magnetic Flow Meters
	17740	Ultrasonic Liquid Level Measurement Systems
	17900	Schedules and Control Descriptions - General
	17910	Instrument Schedule
	17920	Control System Input/Output Schedule
	17950	Functional Control Descriptions

DRAWINGS

	Sheet	Title
GENERAL		
	G1	Cover Sheet
	G2	Index, Abbreviations, Legend, and Notes
	C1	Civil and Erosion and Sediment Control Notes
	C2	Erosion and Sediment Control Notes
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	E1	Symbols and Abbreviations
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	C3-C	Proposed Site Conditions
	C4-C	Enlarged Site and Staking Plan
	C5-C	Profiles - Sheet I
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Standard Details		
	D1	Standard Details
	D2	Standard Details
	D3	Standard Details
	D4	Standard Details
	D5	Standard Details
	D6	Standard Details

ADDENDA:

NUMBER	**DESCRIPTION**	**DATE**
_____	_____	_____
_____	_____	_____
_____	_____	_____

Receipt of all of above is hereby acknowledged.

CONTRACTOR: _____

BY (SIGNATURE): _____

NAME AND TITLE: _____

DATE: _____

BID ITEMS/QUANTITIES

(a) The Contractor shall provide all unit prices or lump sum prices for all bid items on the Bid Form herein. **If a unit price or lump sum price is omitted or left blank the bid and bidder shall be non-responsive.** The bid forms designate which prices are for *Install* only work, complete and in place, (i.e. assumes equipment and/ or materials will be supplied by the City). All other bid prices are for Furnish and Install work, complete and in place.

(b) The quantities shown for unit bid items are based upon the best information available at time of preparation of these bid documents, and are established for the purpose of obtaining a bid price. No adjustments to the bid prices based on changes to quantities will be considered. All bid prices will be held throughout the duration of the contract regardless of any increase or decrease in bid quantity.

(c) Emergency work shall be negotiated with a maximum allowable amount of 50% over the bid price by item. This excludes all lump sum bid items.

(d) All other bid items not listed or described in the Contract Documents will be negotiated between the City and the Contractor before the time of need. Once a negotiated price is established, it will be used for the remainder of the contract.

The undersigned Bidder proposes to complete all work in accordance with the Contract Documents for the following unit prices:

City of Winchester

Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement – ITB #202004

BID TABLE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
General Construction					
1	General Construction of the Work as Shown and Specified Under Divisions 1 Through 17	1	Lump Sum		
Additional Excavation					
2	Additional Excavation of Unsuitable Materials, Including Disposal [Only as Directed by the Owner]	25	Cubic Yards		
Additional Backfill with VDOT 21B Stone					
3	Additional Backfill of Excavated Areas [Only as Directed by the Owner]	25	Cubic Yards		
Additional Pavement Milling and Overlay					
4	Only as Directed by the Owner	500	Square Feet		
Emergency Bypass Pumping System Installation and Removal					
5	Only as Directed by the Owner	1	Lump Sum		
Emergency Bypass Pumping System Operation					
6	Only as Directed by the Owner	1	Month		
Allowance					
7	Completion of programing and incorporation into Owner SCADA by M.C. Dean, Inc	1	Lump Sum		

TOTAL BASE BID: $_____

IN WORDS:

_____

CONTRACTOR: _____

BY: (SIGNATURE) _____

NAME AND TITLE: _____

_____

DATE: _____

ADDRESS: _____

_____

_____

TELEPHONE: _____

CURRENT VIRGINIA CONTRACTOR REGISTRATION NUMBER: _____

NOTE: REQUIRED BID GUARANTEE MUST BE ENCLOSED WITH THIS BID PROPOSAL.

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Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement
ITB #202004

CONTRACTOR QUALIFICATION DATA SHEET

1. General:

In order to be considered for selection, Bidders shall submit the following information as part of your response to this solicitation. Failure to complete and provide this data sheet and the requested information may result in a non-responsive bid.

1.1 Proprietary Information

All source code, executables, user data, materials, meeting minutes, progress reports and documentation shall be submitted to the City and shall belong exclusively to the City, and shall be subject to public inspection in accordance with the Virginia Freedom of Information Act. Trade secrets or proprietary information submitted by a Bidder shall not be subject to public disclosure under the Virginia Freedom of Information Act provided the Bidder invokes the protections of Section 2.2-4342F of the Virginia Public Procurement Act, which provides that:

> "Trade secrets or proprietary information submitted by a Bidder, or subsequently the Contractor, in connection with a procurement transaction, shall not be subject to public disclosure under the Virginia Freedom of Information Act. However, the Bidder or Contractor must invoke the protection of this Section prior to, or upon submission of the data or other materials. The Contractor must identify the data or other materials to be protected and justify in writing the explicit reasons that such protection is necessary. Failure to mark the data or other materials as proprietary or otherwise classified, will result in the data or other materials being released to Bidders or to the public as provided in the Virginia Freedom of Information Act."

The classification of the entire proposal document and total bid price as proprietary or trade secrets is not acceptable.

1.2 Incurred Cost

The Bidder is responsible for all costs of proposal preparation. The City of Winchester is not liable for any costs incurred in response to the ITB.

1.3 Contractor Qualifications:

Proposals should be as thorough and detailed as possible so that City may properly evaluate your capabilities to provide the required services. Bidders shall submit responses for the following items within your Bid response.

1.3.1 General

1.3.1.1 How many years has your organization been in business as a General Contractor?

1.3.1.2 How many years has your organization been in business under its present name?

1.3.1.3 What is your organization's Virginia Contractors Registration Number?

1.3.1.4 List the states and categories of construction in which your organization is legally qualified to do business?

1.3.1.5 *Qualifications:* Provide a description of the organizational structure and history. Identify key personnel to be assigned to this project and their relevant experience in work similar to this project.

1.3.1.6 *Debarment/Suspension List:* Firms shall confirm in writing that they are not currently on any debarment or suspension list of any local, state or federal government. Any firm found to be listed shall be rejected as non-responsive.

1.3.2 Construction-Specific

1.3.2.1 *Quality Management Plan and Timeliness Tracking Plan*

The Contractor shall provide a detailed description of all internal control methods used to insure quality throughout all of the contractor's operations, as well as the system or method that will be employed to track, monitor, and ensure compliance with all time line requirements of this ITB.

1.4.2.2 *Past Project Experience*

The Contractor shall provide a minimum of three (3) references that are similar in nature to the City's proposed construction project. The City prefers that contractors have significant experience in pump station construction. The submitted projects shall have been initiated or completed in the past five (5) years and exceed $500,000 of total value. In the response, the Contractor shall provide a one to two paragraph description of the work performed, and the name, address, telephone number, and email address of the owner's representative. For each reference, the response shall also delineate the specific value of the underground utility installations, as defined above, as well as the total value of all the work completed.

The Contractor shall include in this list any contract(s) in the past five (5) years that were terminated and shall provide the reason for termination.

1.4.2.3 *Management of Simultaneous Contracts*

The Contractor shall list all the name of projects, owner's name and address, percent complete and scheduled completion of the major projects in progress on the date of proposal submittal and the estimated contract amount of all executed contracts that will be underway at the same time as the City's proposed construction project. The contractor shall also state how the contract needs of the City will be met with the available company resources considering that these other contracts will be underway simultaneously.

1.4.3 Financial Statements

Please submit your company's audited annual financial statement and/or Dunn & Bradstreet report for the last two (2) years.

1.4.4 Subcontracting Restrictions

The Prime Contractor shall perform or exercise responsibility for this contract with its own work force for at least 50% of the total dollar value of the contract. Identify the sub-Contractor(s) who will do work on this project and the amount of work that each is projected to perform.

1.4.5 Certification

An authorized representative of the company shall sign the Technical Proposal, which shall include the following statement above the name/signature/date line:

I certify that the information provided in the Contractor Qualifications is complete and accurate to the best of my knowledge.

Authorized Signature Title Date

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BID BOND

KNOW ALL MEN BY THESE PRESENTS THAT_____

_____
(Here insert the name & address or legal title of the Contractor)

as Principal, hereinafter called the Contractor and _____

_____
(Here insert the legal title of the Surety)

as Surety, hereinafter called the Surety, are held and firmly bound unto the City of Winchester, Virginia, as obligee, hereinafter called the Owner, in the amount of

_____
(Dollars)

($_____) for the payment whereof Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has submitted a Bid for:

ITB #202004 – Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

in accordance with Drawing and Specifications prepared by the Public Services Department, City of Winchester, Virginia.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if the Obligee shall accept the Bid of the Principal and the Principal shall enter into a Contract with the Obligee in accordance with terms of such Bid, and give such bonds as specified in the Contract Documents with good and sufficient surety for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter such Contract and give such bonds, if the Principal shall pay the Obligee the difference not to exceed the penalty hereof between the amount specified in said Bid and such larger amount for which the Obligee may in good faith contract with another party to perform the Work covered by said Bid, then this obligation shall be null and void, otherwise to remain in full force and effect.

SIGNED AND SEALED THIS_____DAY OF_____A.D., 2020.

_____
PRINCIPAL

_____
TITLE

_____
WITNESS

_____
SURETY

_____
TITLE

_____
WITNESS

NON-COLLUSION AFFIDAVIT

STATE OF VIRGINIA

Ss: **ITB #202004 – Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement**

CITY OF WINCHESTER, COUNTY of FREDERICK

I, _____ of the City of _____

In the County of _____ and the State of _____

Of full age, being duly sworn according to law or my oath depose and say that:

I am _____ of the firm of _____

_____, of the Company making the Bid for the above named project, and that I executed the said Bid with full authority to do so; that the Company has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free, competitive bid preparation in connection with the above named project; and that all statements contained in said Bid and in this affidavit are true and correct, and made with full knowledge that the City of Winchester relies upon the truth of the statements contained in said Bid and in the statements contained in this affidavit in awarding the Contract for said Project.

I further warrant that no person or selling agency has been employed or retained to solicit or secure such contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, except bona fide employees or bona fide established commercial or selling agencies maintained by:

_____
(Name of Contractor)

Subscribed and sworn to _____
(Type or print name of applicant under signature)

before me this _____ day of _____, 20____.

_____
(Notary Public)

of _____
My commission expires: _____, 20____.

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Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement
ITB # 202004

CONTRACT

THIS CONTRACT, made and entered into in triplicate originals this _____ day of **_____, 2020**, by and between the **City of Winchester, Virginia**, Party of the First Part, hereinafter referred to as the **"Owner"** and _____, Party of the Second Part, hereinafter referred to as the **"Contractor"**.

WITNESSETH, That the Contractor and the City for the consideration stated herein agree as follows:

ARTICLE I, SCOPE OF WORK - The Contractor shall perform everything required to be performed and shall provide and furnish all of the labor, materials, necessary tools, expendable equipment and all utility and transportation services required to perform and complete in a workmanlike manner all the work required in connection with:

ITB #202004 – Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

all in strict accordance with the Contract Documents prepared by the Public Services Department, City of Winchester, Virginia. The Contractor shall do everything required by this Contract and other Documents constituting a part thereof.

ARTICLE II, CONTRACT PRICE - The City shall pay to the Contractor for the performance of this Contract, subject to any additions or deductions provided therein, in current funds, the Contract Price computed as follows:

TOTAL CONTRACT PRICE= _____

ARTICLE III. PAYMENTS - Payments are to be made to the Contractor in accordance with and subject to provisions embodied in the Documents made a part of this Contract.

ARTICLE IV. CONTRACT TIME - Work under this Contract shall commence no later than the date to begin work set forth in a written Notice to Proceed from the City or its authorized representative, to the Contractor. The Contractor shall complete all work under this Contract within **365 calendar days** following the Notice to Proceed issued for the project.

The Work shall be prosecuted (performed) regularly, diligently and uninterruptedly at such rate of progress as will insure full completion thereof within the time specified. **It is expressly understood and agreed by and between the Contractor and the City that the**

time for the completion of the Work described herein is a reasonable time for the completion of the same.

ARTICLE V. ENGINEER – The project has been designed by the City of Winchester Public Services Department, Engineering Division, 15 N. Cameron Street, Winchester, VA 22601, who is hereinafter called ENGINEER and who is to act as OWNER's representative, assume all duties and responsibilities and have the rights and authority assigned to ENGINEER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE VI. HOLD HARMLESS CLAUSE - Bids shall provide that during the term of the Contract, including warranty period, for the successful bidder indemnifying, defending, and holding harmless the City, its officers, employees, agent and representatives thereof from all suits, actions, claims of any kind, including attorney's fees, brought on account of any personal injuries, damages, or violation of rights sustained by any person or property in consequence of any neglect in safeguarding contract work, or on account of any act or omission by the Contractor or his employees, or from any claims or amounts arising from violation of any law, bylaw, ordinance, regulation or decree. The Contractor agrees that this clause shall include claims involving infringement of patent or copyrights.

ARTICLE VII. LIQUIDATED DAMAGES AND INCENTIVES - **It is hereby fully understood and agreed that the time is of essence in the performance of this Contract**. For each and every calendar day that elapses between the Contract Completion Dates specified in Article IV of this Contract and the date on which the work covered by such Contract is actually completed, including the removal of facilities and obstructions from the site of such work, the Contractor shall pay to the City as liquidated damages and not as a penalty, the sum of ONE THOUSAND DOLLARS PER CALENDAR DAY ($1,000.00). The total amount so payable by the Contractor as liquidated damages either may be deducted from any moneys due or payable to the Contractor by the City or so much thereof as is not so deducted shall be chargeable to and will be payable promptly by such Contractor and his Surety, or either of them, to the City. Such liquidated damages shall be payable to reimburse or compensate, at least in part, the City for (1) the administration of the work covered by such Contract and any other contract or contracts beyond the Contract Completion Date, including the additional expense to the City for supervision, inspection, and superintendence; (2) expenditures resulting from the inability of the City (and the general public) to use the improvement being constructed from and after such Contract Completion Date until the actual date of completion; (3) other miscellaneous obligations and expenditures incurred by the City directly as a result of the failure to complete the Work covered by such Contract on or before the Contract Completion Date.

ARTICLE VIII. COMPONENT PARTS OF THIS CONTRACT - That this Contract consists of the following component parts which are made a part of this agreement and Contract as fully and absolutely as if they were set out in detail in this Contract:

BIDDING DOCUMENTS

- Invitation to Bid
- Instructions to Bidders
- Bid Form
- Contractor Qualification Data Sheet
- Bid Bond
- Non-Collusion Affidavit
- Contract
- Performance Bond
- Labor and Material Payment Bond
- Notice of Intent to Award
- Notice of Award
- Notice to Proceed
- City of Winchester Required General Terms and Conditions
- General Conditions
- Supplement to General Conditions
- Special Terms and Conditions

TECHNICAL SPECIFICATIONS

Division	Section	Title
1		GENERAL REQUIREMENTS
	01010	Summary of Work
	01025	Measurement and Payment
	01040	Coordination
	01025	Measurement and Payment
	01070	Abbreviations
	01090	Reference Standards
	01200	Project Meetings
	01300	Submittals
	01320	Progress Schedule
	01400	Quality Control
	01510	Temporary Utilities
	01520	Maintenance of Utility Operations During Construction
	01525	Emergency Bypass Pumping System
	01530	Protection of Existing Facilities
	01540	Demolition and Removal of Existing Structures and Equipment
	01550	Site Access and Storage
	01560	Temporary Environmental Controls
	01600	Materials and Equipment
	01650	Start-Up and Field Testing
	01700	Project Closeout
2		SITEWORK
	02100	Clearing, Grubbing, and Site Preparation
	02200	Earthwork

	02207	Aggregate Materials
	02214	Flowable Fill
	02274	Geotextiles
	02276	Erosion and Sediment Control
	02500	Surface Restoration
	02510	Paving and Surfacing
	02604	Utility Structures
	02831	Steel Fencing
	02910	Final Grading and Landscaping
3		CONCRETE
	03100	Concrete Formwork
	03200	Reinforcing Steel
	03250	Concrete Accessories
	03290	Joints in Concrete
	03300	Cast-in-Place Concrete
	03350	Concrete Finishes
	03370	Concrete Curing
	03400	Precast Concrete
	03452	Architectural Precast Concrete Utility Buildings
	03600	Grout
5		METALS
	05010	Metal Materials
	05035	Galvanizing
	05050	Metal Fastening
	05061	Stainless Steel
	05120	Structural Steel
	05515	Ladders
	05520	Handrails and Railings
	05531	Gratings, Access Hatches, and Access Doors
	05540	Castings
	05830	Bearing Devices and Anchoring
7		THERMAL AND MOISTURE PROTECTION
	07900	Joint Fillers, Sealants and Caulking
9		FINISHES
	09900	Painting
10		SPECIALTIES
	10523	First Aid Cabinets
	10800	Toilet and Bath Accessories
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	11000	Equipment, General Provisions
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Standard Details		
	D1	Standard Details
	D2	Standard Details
	D3	Standard Details
	D4	Standard Details
	D5	Standard Details
	D6	Standard Details

ADDENDA:

Above components are complimentary and what is called for by one shall be binding as if called by all.

IN WITNESS WHEREOF, the parties hereto have hereunto set their hands and seals the date first written above.

CONTRACTOR:	CITY OF WINCHESTER, VIRGINIA:
_____	_____ CITY MANAGER
_____ NAME AND TITLE	_____ ATTEST

_____
ATTEST

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, that we_____

_____as Principal, hereinafter

called Contractor, and _____

Surety Company, with General Offices in _____

_____, a corporation organized under the laws of the Commonwealth of _____ and authorized to transact business in the Commonwealth of Virginia as Surety, hereinafter called Surety, are held and firmly bound onto the City of Winchester, Virginia, hereinafter called Owner, in the penal sum _____
(_____)Dollars, lawful money of the United States, for the payment of which sum, will and truly be made, the Said Contractor and Surety bind themselves, their successors and assigns, jointly and severally, firmly by these presents.

Signed, sealed and delivered this____day of _____, 2020.

WHEREAS, the above named and bounded Contractor has entered into a written contract with the Owner, dated_____, 2020 for:

ITB #202004 – Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

in accordance with the Drawings and Specifications prepared by the Engineering Department, City of Winchester, Virginia, which Contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if the Contractor shall promptly and faithfully perform said Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

The Surety hereby waives notice of any alteration or extension of time made by the Owner.

Whenever Contractor shall be, and declared by Owner to be in default under the Contract, the Owner having performed Owner's obligations thereunder, the Surety may promptly remedy the default, or shall promptly:

1. Complete the Contract in accordance with its terms and conditions, or

2. Obtain a bid or bids for completing the Contract in accordance with its terms and conditions, and upon determination by Surety of the lowest responsible bidder, or, if the Owner elects, upon determination by the Owner and the Surety jointly of the lowest responsible bidder, arrange for a contract between such bidder and Owner, and make available as work progresses (even though there should be a default or a succession of defaults under the contract or contracts of completion arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the contract price; but not exceeding, including other costs and damages for which Surety may be liable hereunder, the amount set forth in the first paragraph hereof. The term "balance of contract price," as used in this paragraph, shall mean the total amount payable by the Owner to Contractor under the Contract and any amendments thereto, less the amount properly paid by Owner to Contractor.

Any suit under this bond must be instituted before the expiration of two (2) years from the date on which final payment under the Contract falls due.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the Owner named herein or the heirs, executors, administrators or successors of the Owner.

Signed and sealed this _____day of_____ 2020.

_____	_____
PRINCIPAL	SURETY
_____	_____
TITLE	TITLE
_____	_____
WITNESS	WITNESS

LABOR AND MATERIAL PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, that we _____

_____as Principal, hereinafter

called Contractor, and _____

Surety Company, with General Offices in _____

_____, a corporation organized under the laws of the Commonwealth of _____ and authorized to transact business in the Commonwealth of Virginia as Surety, hereinafter called Surety, are held and firmly bound unto the City of Winchester, Virginia, hereinafter called Owner, in the penal sum _____ (_____)Dollars, lawful money of the United States, for the payment of which sum, will and truly be made, the Said Contractor and Surety bind themselves, their successors and assigns, jointly and severally, firmly by these presents.

Signed, sealed and delivered this _____day of_____ 2020.
WHEREAS, the above named and bounded Contractor has entered into a written contract with the Owner, dated_____, 2020 for:

ITB #202004 – Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

in accordance with the Drawings and Specifications prepared by the Engineering Department, City of Winchester, Virginia, which Contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if the Contractor shall promptly make payment to all claimants as hereinafter defined, for all labor and material used or reasonably required for use in the performance of the Contract, then this obligation shall be void; otherwise it shall remain full force and effect, subject, however, to the following conditions:

1. A claimant is defined as one having a direct contract with the Principal or with a Subcontractor of the Principal for labor, material, or both, used or reasonably required for use in the performance of the Contract, labor and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental of equipment directly applicable to the Contract.

2. The above named Principal and Surety hereby jointly and severally agree with the Owner that every claimant as herein defined, who has not been paid in full before

the expiration of a period of ninety (90) days after the date on which the last of such claimant's work or labor was done or performed, or materials were furnished by such claimant, may sue on this bond for the use of such claimant, prosecute the suit to final judgement for such sum or sums as my be justly due claimant, and have execution thereon. The Owner shall not be liable for the payment of any costs or expenses of any such suit.

3. No suit or action shall be commenced hereunder by any claimant:

a) Unless claimant, other than the one having a direct Contract with the Principal, shall have given written notice to any two of the following: the Principal, the Owner, or the Surety above named, within (90) days after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage paid, in an envelope addressed to the Principal, Owner or Surety, at any place where an office is regularly maintained for the transaction of business, or served in any manner in which legal process may be served in the state in which the aforesaid project is located, save that such service need not be made by a public officer.

b) After the expiration of one (1) year following the date on which Principal ceased work on said Contract, it being understood, however, that if any limitation embodied in this bond is prohibited by any law controlling the construction hereof such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

c) Other than in a state court of competent jurisdiction in and for the county or other political subdivision of the state in which the project, or any part thereof, is situated, or in the United States District Court for the district in which the project, or any part thereof, is situated, and not elsewhere.

4. The amount of this bond shall be reduced by and to the extent of any payment or payments made in good faith hereunder, inclusive of the payment by Surety of mechanic's liens which may by be filed of record against said improvement, whether or not claim for the amount of such lien be presented under and against this bond.

Signed and sealed this _____day of_____, 2020.

_____
PRINCIPAL

_____
TITLE

_____
WITNESS

_____
SURETY

_____
TITLE

_____
WITNESS

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CITY OF WINCHESTER, VIRGINIA

NOTICE OF INTENT TO AWARD

Date:

To:

Thank you for your proposal concerning our Invitation to Bid For: **ITB # 202004 - Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement**

The City of Winchester intends to award this Invitation to Bid to:

This is not a Notice of Award or a Notice to Proceed.

Sincerely,

Michael Marzullo, CPPB
City of Winchester
Purchasing
Finance Department
15 N. Cameron Street
Winchester, VA 22601
(540) 667-1815 EXT 1477

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NOTICE OF AWARD

DATE:

TO:

PROJECT TITLE: **ITB# 202004 – Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement**

Gentlemen:

Your Bid, dated _____, for the above Project has been considered and you are the apparent successful bidder. You are hereby notified that you have been awarded a Contract for:

The Contract Price of your contract is $_____.

Three copies each of the proposed Contract between Owner and Contractor and the Contract Documents accompany this Notice of Award.

You must comply with the following conditions precedent within fifteen days of the date of this Notice of Award, that is by _____.

1. You must deliver to the Owner three (3) fully executed counterparts of the Contract between Owner and Contractor including all the Contract Documents. This includes the sets of Plans and Specifications. Each of the Contract Documents must bear your signature on the Index page of the Plans and on the Specification Table of Contents page.
2. You must deliver with the executed Contract, Payment and Performance Bonds, and required Certificates of Insurance. The Certificate of Insurance must identify the above referenced project as the project for which insurance is being provided. *Additionally, it must indicate the City of Winchester as the Certificate Holder, and name the City of Winchester as an additional insured.*

Failure to comply with these conditions within the time specified will entitle Owner to consider your bid abandoned, to annul this Notice of Award and to declare your Bid Security forfeited.

After you comply with those conditions, and upon approval of the Contract Security by the Owner, the Owner will return to you one fully signed counterpart of the Contract with the Contract Documents.

City of Winchester, Virginia

By: _____
City Manager

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NOTICE TO PROCEED

DATE:

TO:

Re: City of Winchester, Department of Public Services

PROJECT TITLE: **ITB #202004 – Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement**

Gentlemen:

In accordance with the Contract between Owner and Contractor, you are notified that the Time for Completion under the above Contract will commence to run on _____, 2020. By that date, you are to start performing your obligations under the Contract Documents. In accordance with the Contract between Owner and Contractor, the Work shall be substantially completed within 365 calendar days which is _____, 2021.

City of Winchester, Virginia

By: _____
City Manager

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CITY OF WINCHESTER

REQUIRED GENERAL TERMS AND CONDITIONS

A. APPLICABLE LAWS AND COURTS
B. ANTI-DISCRIMINATION
C. ETHICS IN PUBLIC CONTRACTING
E. IMMIGRATION REFORM AND CONTROL ACT OF 1986
F. DEBARMENT STATUS
G. ANTITRUST
H. MANDATORY USE OF CITY FORM AND TERMS AND CONDITIONS
I. CLARIFICATION OF TERMS
J. PAYMENT
K. PRECEDENCE OF TERMS
L. QUALIFICATIONS OF BIDDERS OR OFFERORS
M. TESTING AND INSPECTION
N. ASSIGNMENT OF CONTRACT
O. SEVERABILITY
P. CHANGES TO THE CONTRACT
Q. DEFAULT
R. TAXES
S. USE OF BRAND NAMES
T. TRANSPORTATION AND PACKAGING
U. INSURANCE
V. ANNOUNCEMENT OF AWARD
W. DRUG-FREE WORKPLACE
X. NONDISCRIMINATION OF CONTRACTORS
Y. AVAILABILITY OF FUNDS
Z. LICENSES AND PERMITS
AZ. TERMINATION
BZ. HOLD HARMLESS INDEMNIFICATION
CZ. CONFIDENTIALITY OF PERSONALLY IDENTIFIABLE INFORMATION
DZ. BID PRICE CURRENCY

These General Terms and Conditions are required for all sealed and unsealed written or verbal solicitations issued by the City of Winchester for procurements that are subject to the Winchester City Code unless changed, deleted or revised by the City Attorney.

A. **APPLICABLE LAWS AND COURTS:** This solicitation and any resulting contract shall be governed by the laws of the Commonwealth of Virginia. Any dispute arising from the performance or non-performance of this Agreement shall be resolved or otherwise litigated in the Circuit Court for the City of Winchester, Virginia or the Fourth Circuit Federal District Court in Harrisonburg, Virginia. The agency and the contractor are encouraged to resolve any issues in controversy arising from the award of the contract or any contractual dispute following the Winchester City Code, Chapter 21-61. The contractor shall comply with all applicable federal, state and local laws, rules and regulations.

B. **ANTI-DISCRIMINATION:** By submitting their (bids/proposals), (bidders/offerors) certify to the City of Winchester that they will conform to the provisions of the Federal Civil Rights Act of 1964, as amended, as well as the Virginia Fair Employment Contracting Act of 1975, as amended, where applicable, the Virginians With Disabilities Act, the Americans With Disabilities Act and § 2.2-4311 of the *Virginia Public Procurement Act (VPPA).* If the award is made to a faith-based organization, the organization shall not discriminate against any recipient of goods, services, or disbursements made pursuant to the contract on the basis of the recipient's religion, religious belief, refusal to participate in a religious practice, or on the basis of race, age, color, gender or national origin and shall be subject to the same rules as other organizations that contract with public bodies to account for the use of the funds provided; however, if the faith-based organization segregates public funds into separate accounts, only the accounts and programs funded with public funds shall be subject to audit by the public body. (*Code of Virginia*, § 2.2-4343.1E).

In every contract over $10,000 the provisions in 1. and 2. below apply:

1. During the performance of this contract, the contractor agrees as follows:

a. The contractor will not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, age, disability, or any other basis prohibited by state law relating to discrimination in employment, except where there is a bona fide occupational qualification reasonably necessary to the normal operation of the contractor. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause.

b. The contractor, in all solicitations or advertisements for employees placed by or on behalf of the contractor, will state that such contractor is an equal opportunity employer.

c. Notices, advertisements and solicitations placed in accordance with federal law, rule or regulation shall be deemed sufficient for the purpose of meeting these requirements.

2. The contractor will include the provisions of 1. above in every subcontract or purchase order over $10,000, so that the provisions will be binding upon each subcontractor or vendor.

C. **ETHICS IN PUBLIC CONTRACTING:** By submitting their (bids/proposals), (bidders/offerors) certify that their (bids/proposals) are made without collusion or fraud and that they have not offered or received any kickbacks or inducements from any other (bidder/offeror), supplier, manufacturer or subcontractor in connection with their (bid/proposal), and that they have not conferred on any public employee having official responsibility for this procurement transaction any payment, loan, subscription, advance, deposit of money, services or anything of more than nominal value, present or promised, unless consideration of substantially equal or greater value was exchanged.

D. **IMMIGRATION REFORM AND CONTROL ACT OF 1986:** By submitting their (bids/proposals), (bidders/offerors) certify that they do not and will not during the performance of this contract employ illegal alien workers or otherwise violate the provisions of the federal Immigration Reform and Control Act of 1986.

E. **DEBARMENT STATUS:** By submitting their (bids/proposals), (bidders/offerors) certify that they are not currently debarred by the Federal Government, Commonwealth of Virginia, or by any City, Town or County from submitting bids or proposals on contracts for the type of goods and/or services covered by this solicitation, nor are they an agent of any person or entity that is currently so debarred.

F. **ANTITRUST:** By entering into a contract, the contractor conveys, sells, assigns, and transfers to the City of Winchester all rights, title and interest in and to all causes of action it may now have or hereafter acquire under the antitrust laws of the United States and the Commonwealth of Virginia, relating to the particular goods or services purchased or acquired by the City of Winchester under said contract.

H. **MANDATORY USE OF CITY FORM AND TERMS AND CONDITIONS:** Failure to submit a bid/proposal on the official City form provided for that purpose may be a cause for rejection of the bid/proposal. Modification of or additions to the General Terms and Conditions of the solicitation may be cause for rejection of the bid/proposal; however, the City of Winchester reserves the right to decide, on a case by case basis, in its sole discretion, whether to reject such a bid/proposal.

I. **CLARIFICATION OF TERMS:** If any prospective (bidder/offeror) has questions about the specifications or other solicitation documents, the prospective (bidder/offeror) should contact the buyer whose name appears on the face of the solicitation no later than five working days before the due date. Any revisions to the solicitation will be made only by addendum issued by the Purchasing Agent, or designee.

J. **PAYMENT:**

1. To Prime Contractor:

a. Invoices for items ordered, delivered and accepted shall be submitted by the contractor directly to the payment address shown on the purchase order/contract. All invoices shall show the state contract number and/or purchase order number; social security number (for individual contractors) or the federal employer identification number (for proprietorships, partnerships, and corporations).

b. Any payment terms requiring payment in less than 30 days will be regarded as requiring payment 30 days after invoice or delivery, whichever occurs last. This shall not affect offers of discounts for payment in less than 30 days, however.

c. All goods or services provided under this contract or purchase order, that are to be paid for with public funds, shall be billed by the contractor at the contract price, regardless of which department is being billed.

d. The following shall be deemed to be the date of payment: the date of postmark in all cases where payment is made by mail.

e. **Unreasonable Charges**. Under certain emergency procurements and for most time and material purchases, final job costs cannot be accurately determined at the time orders are placed. In such cases, contractors should be put on notice that final payment in full is contingent on a determination of reasonableness with respect to all invoiced charges. Charges which appear to be unreasonable will be researched and challenged, and that portion of the invoice held in abeyance until a settlement can be reached. Upon determining that invoiced charges are not reasonable, the City of Winchester shall promptly notify the contractor, in writing, as to those charges which it considers unreasonable and the basis for the determination. A contractor may not institute legal action unless a settlement cannot be reached within thirty (30) days of notification. The provisions of this section do not relieve an agency of its prompt payment obligations with respect to those charges which are not in dispute (*Code of Virginia,* § 2.2-4363).

2. To Subcontractors:

a. A contractor awarded a contract under this solicitation is hereby obligated:

(1) To pay the subcontractor(s) within seven (7) days of the contractor's receipt of payment from the City of Winchester for the proportionate share of the payment received for work performed by the subcontractor(s) under the contract; or

(2) To notify the agency and the subcontractor(s), in writing, of the contractor's intention to withhold payment and the reason.

b. The contractor is obligated to pay the subcontractor(s) interest at the rate of one percent per month (unless otherwise provided under the terms of the contract) on all amounts owed by the contractor that remain unpaid seven (7) days following receipt of payment from the City of Winchester, except for amounts withheld as stated in (2) above. The date of mailing of any payment by U. S. Mail is deemed to be payment to the addressee. These provisions apply to each sub-tier contractor performing under the primary contract. A contractor's obligation to pay an interest charge to a subcontractor may not be construed to be an obligation of the City of Winchester.

K. **PRECEDENCE OF TERMS:** The following General Terms and Conditions APPLICABLE LAWS AND COURTS, ANTI-DISCRIMINATION, ETHICS IN PUBLIC CONTRACTING, IMMIGRATION REFORM AND CONTROL ACT OF 1986, DEBARMENT STATUS, ANTITRUST, MANDATORY USE OF CITY FORM AND TERMS AND CONDITIONS, CLARIFICATION OF TERMS, PAYMENT shall apply in all instances. In the event there is a conflict between any of the other General Terms and Conditions and any Special Terms and Conditions in this solicitation, the Special Terms and Conditions shall apply and take precedence.

The City's procurement, Contractor's response and written negotiation summary shall form part of the Contract. In the case of conflicts, discrepancies, errors or omissions among the City's procurement, the Contractor's response, written negotiation summary and the main body of the Contract, the documents and amendments to them shall take precedence and govern in the following order:

1. Contract
2. Negotiation Summary
3. City's Procurement Document(s)
4. Contractor's Response
5. Other Documents

L. **QUALIFICATIONS OF (BIDDERS/OFFERORS):** The City of Winchester may make such reasonable investigations as deemed proper and necessary to determine the ability of the (bidder/offeror) to perform the services/furnish the goods and the (bidder/offeror) shall furnish to the City of Winchester all such information and data for this purpose as may be requested. The City of Winchester reserves the right to inspect (bidder's/offeror's) physical facilities prior to award to satisfy questions regarding the (bidder's/offeror's) capabilities. The City of Winchester further reserves the right to reject any (bid/proposal) if the evidence submitted by, or investigations of, such (bidder/offeror) fails to satisfy the City of Winchester that such (bidder/offeror) is properly qualified to carry out the obligations of the contract and to provide the services and/or furnish the goods contemplated therein.

M. **TESTING AND INSPECTION:** The City of Winchester reserves the right to conduct any test/inspection it may deem advisable to assure goods and services conform to the specifications.

N. **ASSIGNMENT OF CONTRACT:** A contract shall not be assignable by the contractor in whole or in part without the written consent of the City of Winchester.

O. **SEVERABILITY OF CONTRACT:** In the event that any provision shall be adjudged or decreed to be invalid, such ruling shall not invalidate the entire Agreement but shall pertain only to the provision in question and the remaining provisions shall continue to be valid, binding and in full force and effect.

P. **CHANGES TO THE CONTRACT:**

1. A public contract may include provisions for modification of the contract during performance, but no fixed-price contract may be increased by more than twenty-five percent of the amount of the contract or ten thousand dollars ($10,000), whichever is greater, without the advance written approval of the City Council. In no event may the amount of any contract, without adequate consideration, be increased for any purpose, including, but not limited to, relief of an offeror from the consequences of an error in its bid or offer (Winchester City Code 21-44).

2. Changes can be made to the contract in any of the following ways:

   a. The parties may agree in writing to modify the scope of the contract. An increase or decrease in the price of the contract resulting from such modification shall be agreed to by the parties as a part of their written agreement to modify the scope of the contract.

   b. The City of Winchester may order changes within the general scope of the contract at any time by written notice to the contractor. Changes within the scope of the contract include, but are not limited to, things such as services to be performed, the method of packing or shipment, and the place of delivery or installation. The contractor shall comply with the notice upon receipt. The contractor shall be compensated for any additional costs incurred as the result of such order and shall give the City of Winchester a credit for any savings. Said compensation shall be determined by one of the following methods:

      1. By mutual agreement between the parties in writing; or
      2. By agreeing upon a unit price or using a unit price set forth in the contract, if the work to be done can be expressed in units, and the contractor accounts for the number of units of work performed, subject to the City of Winchester's right to audit the contractor's records and/or to determine the correct number of units independently; or
      3. By ordering the contractor to proceed with the work and keep a record of all costs incurred and savings realized. A markup for overhead and profit may be allowed if provided by the contract. The same markup shall be used for determining a decrease in price as the result of savings realized. The contractor shall present the City of Winchester with all vouchers and records of expenses incurred and savings realized. The City of Winchester shall have the right to audit the records of the contractor as it deems necessary to determine costs or savings. Any claim for an adjustment in price under this provision must be asserted by written notice to the City of Winchester within thirty (30) days from the date of receipt of the written order from the City of Winchester. If the parties fail to agree on an amount of adjustment, the question of an increase or decrease in the contract price or time for performance shall be resolved in accordance with the procedures for resolving disputes provided by the Disputes Clause of this contract or, if there is none, in accordance with the disputes provisions of the City of Winchester Code. Neither the existence of a claim nor a dispute resolution process, litigation or any other provision of this contract shall excuse the contractor from promptly complying with the changes ordered by the City of Winchester or with the performance of the contract generally.

Q. **DEFAULT:** In case of failure to deliver goods or services in accordance with the contract terms and conditions, the City of Winchester, after due oral or written notice, may procure them from other sources and hold the contractor responsible for any resulting additional purchase and administrative costs. This remedy shall be in addition to any other remedies which the City of Winchester may have.

R. **TAXES:** Sales to the City of Winchester are normally exempt from State sales tax. State sales and use tax certificates of exemption, Form ST-12, will be issued upon request.

S. **USE OF BRAND NAMES:** Unless otherwise provided in this solicitation, the name of a certain brand, make or manufacturer does not restrict (bidders/offerors) to the specific brand, make or manufacturer named, but conveys the general style, type, character, and quality of the article desired. Any article which the public body, in its sole discretion, determines to be the equal of that specified, considering quality, workmanship, economy of operation, and suitability for the purpose intended, shall be accepted. The (bidder/offeror) is responsible to clearly and specifically identify the product being offered and to provide sufficient descriptive literature, catalog cuts and technical detail to enable the City of Winchester to determine if the product offered meets the requirements of the solicitation. This is required even if offering the exact brand, make or manufacturer specified. Normally in competitive sealed bidding only the information furnished with the bid will be considered in the evaluation. Failure to furnish adequate data for evaluation purposes may result in declaring a bid nonresponsive. Unless the (bidder/offeror) clearly indicates in its (bid/proposal) that the product offered is an equal product, such (bid/proposal) will be considered to offer the brand name product referenced in the solicitation.

T. **TRANSPORTATION AND PACKAGING:** By submitting their (bids/proposals), all (bidders/offerors) certify and warrant that the price offered for FOB destination includes only the actual freight rate costs at the lowest and best rate and is based upon the actual weight of the goods to be shipped. Except as otherwise specified herein, standard commercial packaging, packing and shipping containers shall be used. All shipping containers shall be legibly marked or labeled on the outside with purchase order number, commodity description, and quantity.

U. INSURANCE: By signing and submitting a bid or proposal under this solicitation, the bidder or offeror certifies that if awarded the contract, it will have the following insurance coverage at the time the contract is awarded. For construction contracts, if any subcontractors are involved, the subcontractor will have workers' compensation insurance in accordance with §§ 2.2-4332 and 65.2-800 et seq. of the *Code of Virginia*. The bidder or offeror further certifies that the contractor and any subcontractors will maintain these insurance coverage during the entire term of the contract and that all insurance coverage will be provided by insurance companies authorized to sell insurance in Virginia by the Virginia State Corporation Commission.

MINIMUM INSURANCE COVERAGES AND LIMITS REQUIRED FOR MOST CONTRACTS:

1. Workers' Compensation - Statutory requirements and benefits. Coverage is compulsory for employers of three or more employees, to include the employer. Contractors who fail to notify the City of Winchester of increases in the number of employees that change their workers' compensation requirements under the *Code of Virginia* during the course of the contract shall be in noncompliance with the contract. The insurer must have an A.M. Best rating of A- or better.

2. Employer's Liability - $100,000.

3. Commercial General Liability - $1,000,000 per occurrence. Commercial General Liability is to include bodily injury and property damage, personal injury and advertising injury, products and completed operations coverage. The City of Winchester must be named as an additional insured and so endorsed on the policy by the insurer. A notation on the certificate of insurance is not sufficient.

4. Automobile Liability - $1,000,000 per occurrence. (Only used if motor vehicle is to be used in the contract.)

NOTE: In addition, various Professional Liability/Errors and Omissions coverages are required when soliciting those services as follows:

Profession/Service	**Limits**
Accounting	$1,000,000 per occurrence, $3,000,000 aggregate
Architecture	$2,000,000 per occurrence, $6,000,000 aggregate
Asbestos Design, Inspection or Abatement Contractors	$1,000,000 per occurrence, $3,000,000 aggregate
Health Care Practitioner (to include Dentists, Licensed Dental Hygienists, Optometrists, Registered or Licensed Practical Nurses, Pharmacists, Physicians, Podiatrists, Chiropractors, Physical Therapists, Physical Therapist Assistants, Clinical Psychologists, Clinical Social Workers, Professional Counselors, Hospitals, or Health Maintenance Organizations.)	$1,925,000 per occurrence, $3,000,000 aggregate

(Limits increase each July 1 through fiscal year 2008, as follows:

July 1, 2008 - $2,000,000. This complies with §8.01-581.15 of the *Code of Virginia*.

Insurance/Risk Management	$1,000,000 per occurrence, $3,000,000 aggregate
Landscape/Architecture	$1,000,000 per occurrence, $1,000,000 aggregate
Legal	$1,000,000 per occurrence, $5,000,000 aggregate
Professional Engineer	$2,000,000 per occurrence, $6,000,000 aggregate
Surveying	$1,000,000 per occurrence, $1,000,000 aggregate

V. **ANNOUNCEMENT OF AWARD:** Upon the award or the announcement of the decision to award a contract over $50,000, as a result of this solicitation, the Purchasing Agent will publicly post such notice on the City of Winchester's web site (www.winchesterva.gov/purchasing) for a minimum of 10 days.

W. **DRUG-FREE WORKPLACE:** During the performance of this contract, the contractor agrees to (i) provide a drug-free workplace for the contractor's employees; (ii) post in conspicuous places, available to employees and applicants for employment, a statement notifying employees that the unlawful manufacture, sale, distribution, dispensation, possession, or use of a controlled substance or marijuana is prohibited in the contractor's workplace and specifying the actions that will be taken against employees for violations of such prohibition; (iii) state in all solicitations or advertisements for employees placed by or on behalf of the contractor that the contractor maintains a drug-free workplace; and (iv) include the provisions of the foregoing clauses in every subcontract or purchase order of over $10,000, so that the provisions will be binding upon each subcontractor or vendor.

For the purposes of this section, "*drug-free workplace"* means a site for the performance of work done in connection with a specific contract awarded to a contractor, the employees of whom are prohibited from engaging in the unlawful manufacture, sale, distribution, dispensation, possession or use of any controlled substance or marijuana during the performance of the contract.

X. **NONDISCRIMINATION OF CONTRACTORS**: A bidder, offeror, or contractor shall not be discriminated against in the solicitation or award of this contract because of race, religion, color, sex, national origin, age, disability, faith-based organizational status, any other basis prohibited by state law relating to discrimination in employment or because the bidder or offeror employs ex-offenders unless the state agency, department or institution has made a written determination that employing ex-offenders on the specific contract is not in its best interest. If the award of this contract is made to a faith-based organization and an individual, who applies for or receives goods, services, or disbursements provided pursuant to this contract objects to the religious character of the faith-based organization from which the individual receives or would receive the goods, services, or disbursements, the public body shall offer the individual, within a reasonable period of time after the date of his objection, access to equivalent goods, services, or disbursements from an alternative provider.

Y. **AVAILABILITY OF FUNDS:** In the event that funds are not appropriated for this Contract for any City fiscal year, following the City's current year, the Contract shall terminate automatically as of the last day for which funds were appropriated without the City providing written notice to the Contractor prior to the date of termination. The City shall not consider termination of the Contract pursuant to this section default. Upon such termination, the City shall be released from any obligation to make future payments and shall not be liable for cancellation or termination charges.

Z. **LICENSES AND PERMITS:** Contractors will be responsible for all licenses and permits, if required. Any person, firm, or corporation responding to the City's procurement which is required to have a current and valid City of Winchester business license and, in fact, does not, will not be considered a "responsive bidder" as such term is defined by the Code of Virginia §2.2-4301, as amended. Any bid received from such an entity may be rejected, at the City's sole option, for that reason alone. In addition, the successful bidder or offeror will be required to produce affirmative evidence, satisfactory to the Purchasing Agent, or designee that it has such a license, or is not required to have such a license, prior to approval and execution of any contract to perform the work herein described.

AZ **TERMINATION:**

a. Termination for Convenience: The City of Winchester may terminate a contract, in whole or in part, whenever the City OF Winchester determines that such termination is in the best interest of the City of Winchester, without showing cause, upon giving ten (10) days written notice to the vendor.
b. Termination for Default: When the vendor has not performed or has unsatisfactorily performed the contract, the City of Winchester may terminate the contract for default. Upon termination for default, payment may be withheld at the discretion of the City of Winchester. The Vendor will be paid for work satisfactorily performed prior to termination.

BZ **HOLD HARMLESS:** Bids/Proposal shall provide that during the term of the contract, including warranty period, for the successful bidder/offeror indemnifying, defending, and holding harmless the City, its officers, employees, agent and representatives thereof from all suits, actions, claims of any kind (including claims for attorney's fees) brought on account of any personal injuries, damages, or violation of rights sustained by any person or property in consequence of any neglect in safeguarding contract work, or on account of any act or omission by the contractor or his employees, or from any claims or amounts arising from violation of any law, bylaw, ordinance, regulation or decree. The vendor agrees that this clause shall include claims involving infringement of patent or copyrights.

CZ**.** **CONFIDENTIALITY OF PERSONALLY IDENTIFIABLE INFORMATION:** The contractor assures that information and data obtained as to personal facts and circumstances related to patients or clients will be collected and held confidential, during and following the term of this agreement, and will not be divulged without the individual's and the agency's written consent and only in accordance with federal law or the Code of Virginia. Contractors who utilize, access, or store personally identifiably information as part of the performance of a contract are required to safeguard this information and immediately notify the agency of any breach or suspected breach in the security of such information. Contractors shall allow the City to both participate in the investigation of incidents and exercise control over decisions regarding external reporting. Contractors and their employees working on this project may be required to sign a confidentiality statement.

DZ**.** **BID PRICE CURRENCY:** Prices are to be stated in US dollars unless otherwise specified in the solicitation.

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This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the Controlling Law.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

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Construction Specifications Institute

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These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor Nos. C-520 or C-525 (2002 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the EJCDC Construction Documents, General and Instructions (No. C-001) (2002 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (No. C-800) (2002 Edition).

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GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*--Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*--The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

3. *Application for Payment*--The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Asbestos*--Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. *Bid*--The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

6. *Bidder*--The individual or entity who submits a Bid directly to Owner.

7. *Bidding Documents*--The Bidding Requirements and the proposed Contract Documents (including all Addenda).

8. *Bidding Requirements*--The Advertisement or Invitation to Bid, Instructions to Bidders, bid security of acceptable form, if any, and the Bid Form with any supplements.

9. *Change Order*--A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

10. *Claim*--A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*--The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*-- Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor's submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

13. *Contract Price*--The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

14. *Contract Times*--The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any, (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.

15. *Contractor*--The individual or entity with whom Owner has entered into the Agreement.

16. *Cost of the Work*--See Paragraph 11.01.A for definition.

17. *Drawings*--That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and

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other Contractor submittals are not Drawings as so defined.

18. *Effective Date of the Agreement*--The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

19. *Engineer*--The individual or entity named as such in the Agreement.

20. *Field Order*--A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.

21. *General Requirements*--Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

22. *Hazardous Environmental Condition*--The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto in connection with the Work.

23. *Hazardous Waste*--The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

24. *Laws and Regulations; Laws or Regulations*--Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

25. *Liens*--Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *Milestone*--A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. *Notice of Award*--The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.

28. *Notice to Proceed*--A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

29. *Owner*--The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

30. *PCBs*--Polychlorinated biphenyls.

31. *Petroleum*--Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

32. *Progress Schedule*--A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

33. *Project*--The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. *Project Manual*--The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

35. *Radioactive Material*--Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

36. *Related Entity* -- An officer, director, partner, employee, agent, consultant, or subcontractor.

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37. *Resident Project Representative*--The authorized representative of Engineer who may be assigned to the Site or any part thereof.

38. *Samples*--Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

39. *Schedule of Submittals*--A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

40. *Schedule of Values*--A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

41. *Shop Drawings*--All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

42. *Site*--Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.

43. *Specifications*--That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

44. *Subcontractor*--An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

45. *Substantial Completion*--The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

46. *Successful Bidder*--The Bidder submitting a responsive Bid to whom Owner makes an award.

47. *Supplementary Conditions*--That part of the Contract Documents which amends or supplements these General Conditions.

48. *Supplier*--A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or any Subcontractor.

49. *Underground Facilities*--All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

50. *Unit Price Work*--Work to be paid for on the basis of unit prices.

51. *Work*--The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

52. *Work Change Directive*--A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

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1.02 *Terminology*

A. The following words or terms are not defined but, when used in the Bidding Requirements or Contract Documents, have the following meaning.

B. *Intent of Certain Terms or Adjectives*

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered", "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action or determination will be solely to evaluate, in general, the Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. *Day*

1. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents, or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents, or

c. has been damaged prior to Engineer's - recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. *Furnish, Install, Perform, Provide*

1. The word "furnish," when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When "furnish," "install," "perform," or "provide" is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

F. Unless stated otherwise in the Contract Documents, words or phrases which have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project

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Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.04 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review**:**

1. a preliminary Progress Schedule; indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 *Preconstruction Conference*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

2.07 *Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be provided whether or not specifically called for at no additional cost to Owner.

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C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 *Reference Standards*

A. Standards, Specifications, Codes, Laws, and Regulations.

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard, specification, manual or code, or any instruction of a Supplier shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, or Engineer, or any of, their Related Entities, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. Reporting Discrepancies

1. *Contractor's Review of Contract Documents Before Starting Work*: Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor may discover and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. *Contractor's Review of Contract Documents During Performance of Work*: If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor knew or reasonably should have known thereof.

B. Resolving Discrepancies

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

a. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample; (Subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer's written interpretation or clarification.

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3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier or other individual or entity performing or furnishing all of the Work under a direct or indirect contract with Contractor, shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or Engineer's consultants, including electronic media editions; or

2. reuse any of such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaption by Engineer.

B. The prohibition of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

A. Copies of data furnished by Owner or Engineer to Contractor or Contractor to Owner or Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party..

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 - AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

A. *Reports and Drawings:* The Supplementary Conditions identify:

1. those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the Contract Documents; and

2. those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) that Engineer has used in preparing the Contract Documents.

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not

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Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 *Differing Subsurface or Physical Conditions*

A. *Notice:* If Contractor believes that any subsurface or physical condition at or contiguous to the Site that is uncovered or revealed either:

1. is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *Engineer's Review*: After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner's obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer's findings and conclusions.

C. Possible Price and Times Adjustments

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and

b. with respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:

a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or

c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, Owner and Engineer, and any of their Related Entities shall not be liable to Contractor for any claims, costs, losses, or damages (including but

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not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

a. reviewing and checking all such information and data,

b. locating all Underground Facilities shown or indicated in the Contract Documents,

c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction, and

d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 *Hazardous Environmental Condition at Site*

A. *Reports and Drawings:* Reference is made to the Supplementary Conditions for the identification of those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that have been utilized by the Engineer in the preparation of the Contract Documents.

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:

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1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.

D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any.

E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered to Contractor written notice: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.

F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.

G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06. G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

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ARTICLE 5 - BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent must be accompanied by a certified copy of the agent's authority to act.

C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

A. Contractor shall deliver to Owner, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.

B. Owner shall deliver to Contractor, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.

5.04 *Contractor's Liability Insurance*

A. Contractor shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:

a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or

b. by any other person for any other reason;

5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible

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property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, include as additional insured (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

3. include completed operations insurance;

4. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;

5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

6. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment.

a. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 *Owner's Liability Insurance*

A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

A. Unless otherwise provided in the Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;

2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, false work, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, (other than caused by flood) and such other perils or causes of loss as may be specifically required by the Supplementary Conditions;

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

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4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup; and

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other additional insured to whom a certificate of insurance has been issued.

B. Owner shall purchase and maintain such boiler and machinery insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. Prior to commencement of the Work at the Site, Owner shall in writing advise Contractor whether or not such other insurance has been procured by Owner.

5.07 *Waiver of Rights*

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insured or additional insured (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project

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or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order .

B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances. The superintendent will be Contractor's representative at the Site and shall have authority to act on behalf of Contractor. All communications given to or

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received from the superintendent shall be binding on Contractor.

6.02 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05 *Substitutes and "Or-Equals"*

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.

1. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole,

3) it has a proven record of performance and availability of responsive service; and

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b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times, and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. Substitute Items

a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

b. Contractor shall submit sufficient information as provided below to allow Engineer to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented in the General Requirements and as Engineer may decide is appropriate under the circumstances.

d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

1) shall certify that the proposed substitute item will:

a) perform adequately the functions and achieve the results called for by the general design,

b) be similar in substance to that specified, and

c) be suited to the same use as that specified;

2) will state:

a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time;

b) whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and

c) whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified , and

b) available engineering, sales, maintenance, repair, and replacement services;

4) and shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change,

B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." Engineer will

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advise Contractor in writing of any negative determination.

D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

E. *Engineer's Cost Reimbursement*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B Whether or not Engineer approves a substitute item so proposed or submitted by Contractor, Contractor shall reimburse Owner for the charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

F. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 *Concerning Subcontractors, Suppliers, and Others*

A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued . No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity, nor

2. shall anything in the Contract Documents create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, and Engineer,, and all other

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individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of Owner or Engineer its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.08 *Permits*

A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's primary responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

6.11 *Use of Site and Other Areas*

A. Limitation on Use of Site and Other Areas

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1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

6.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Draw-

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ings or Specifications or to the acts or omissions of Owner or Engineer or , or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

D. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 *Hazard Communication Programs*

A. 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 the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the acceptable Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. Shop Drawings

a. Submit number of copies specified in the General Requirements.

b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples:* Contractor shall also submit Samples to Engineer for review and approval in accordance with the acceptable schedule of Shop Drawings and Sample submittals.

a. Submit number of Samples specified in the Specifications.

b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals , any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. Submittal Procedures

1. Before submitting each Shop Drawing or Sample, Contractor shall have determined and verified:

a. all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

b. the suitability of all materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work;

c. all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and

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safety precautions and programs incident thereto; and

d. shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations, that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawing's or Sample Submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 *Continuing the Work*

A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its Related Entities shall be entitled to rely on representation of Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

1. observations by Engineer;

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2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;

6. any inspection, test, or approval by others; or

7. any correction of defective Work by Owner.

6.20 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable .

B. In any and all claims against Owner or Engineer or any of their respective consultants, agents, officers, directors, partners, or employees by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria

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given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 - OTHER WORK AT THE SITE

7.01 *Related Work at Site*

A. Owner may perform other work related to the Project at the Site with Owner's employees, or via other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to Contractor prior to starting any such other work; and

2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.

C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;

2. the specific matters to be covered by such authority and responsibility will be itemized; and

3. the extent of such authority and responsibilities will be provided.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 *Legal Relationships*

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's actions or inactions.

C. Contractor shall be liable to Owner and any other contractor for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's action or inactions.

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ARTICLE 8 - OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

8.02 *Replacement of Engineer*

A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

A. Owner's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site that have been utilized by Engineer in preparing the Contract Documents.

8.06 *Insurance*

A. Owner's responsibilities, if any, in respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 *Change Orders*

A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility in respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 *Evidence of Financial Arrangements*

A. If and to the extent Owner has agreed to furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents, Owner's responsibility in respect thereof will be as set forth in the Supplementary Conditions.

ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents and will not be changed without written consent of Owner and Engineer.

9.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on

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information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.06 *Shop Drawings, Change Orders and Payments*

A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.

D. In connection with Engineer's authority as to Applications for Payment, see Article 14.

9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the

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requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believe that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to, the Resident Project Representative, if any, and assistants, if any.

ARTICLE 10 - CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

A.Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.B.

10.03 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph

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13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

A. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any bond to be given to a surety, the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 *Claims*

A. *Engineer's Decision Required*: All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

B. *Notice:* Written notice stating the general nature of each Claim, shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Time shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).

C. *Engineer's Action*: Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

1. deny the Claim in whole or in part,

2. approve the Claim, or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 - COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 *Cost of the Work*

A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional

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or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items, and shall not include any of the costs itemized in Paragraph 11.01.B.

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time at the Site. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.

4. Costs of special consultants (including but not limited to Engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such

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losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, expresses, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

B. *Costs Excluded:* The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A and 11.01.B.

C. *Contractor's Fee:* When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

D. *Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

11.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances*

1. Contractor agrees that:

a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

b. Contractor's costs for unloading and handling on the Site, labor, installation , overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. Contingency Allowance

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

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11.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

2. there is no corresponding adjustment with respect any other item of Work; and

3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 - CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;

b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraph 12.01.C.2.a is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;

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d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times , or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

C If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

D. Owner, Engineer and the Related Entities of each of them shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of Engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 - TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 *Notice of Defects*

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. All defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspecting, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's Site safety procedures and programs so that they may comply therewith as applicable.

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13.03 *Tests and Inspections*

A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;

2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in said Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.

E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, it must, if requested by Engineer, be uncovered for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If, the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

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A. Promptly after receipt of notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. repair such defective land or areas; or

2. correct such defective Work; or

3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications .

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective

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Work or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 *Progress Payments*

A. Applications for Payments

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may

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make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations on the Site of the executed Work as an experienced and qualified design professional and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

a. the Work has progressed to the point indicated;

b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and to any other qualifications stated in the recommendation); and

c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or

b. that there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

a. to supervise, direct, or control the Work, or

b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or

e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

b. the Contract Price has been reduced by Change Orders;

c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. *Reduction in Payment*

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

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a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;

b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

c. there are other items entitling Owner to a set-off against the amount recommended; or

d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor corrects to Owner's satisfaction the reasons for such action.

3. If it is subsequently determined that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1.

14.03 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

B. Promptly after Contractor's notification, , Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will within 14 days after submission of the tentative certificate to Owner notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will within said 14 days execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to complete or correct items on the tentative list.

14.05 *Partial Utilization*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions.

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1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor will certify to Owner and Engineer that such part of the Work is substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 *Final Payment*

A. Application for Payment

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.7;

b. consent of the surety, if any, to final payment;

c. a list of all Claims against Owner that Contractor believes are unsettled; and

d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner or Owner's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. *Engineer's Review of Application and Acceptance*

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will

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return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. Payment Becomes Due

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and , will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor's disregard of the authority of Engineer; or

4. Contractor's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:

1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the

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Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion),

2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph Owner shall not be required to obtain the lowest price for the Work performed.

D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B, and 15.02.C.

15.03 *Owner May Terminate For Convenience*

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a

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Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 - DISPUTE RESOLUTION

16.01 *Methods and Procedures*

A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.

B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions, or

2. agrees with the other party to submit the Claim to another dispute resolution process, or

3. gives written notice to the other party of their intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 - MISCELLANEOUS

17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

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17.05 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

17.06 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

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1. Delete subparagraph 5.06(A), 5.06(A) Sections 1-7, and subparagraph 5.06(B)

2. Delete sentence in subparagraph 5.07(A) beginning with "All such projects shall contain provisions…."

3. Delete subparagraph 5.07(B), 5.06(B) Sections 1-2, and subparagraph 5.06(C)

4. Delete Paragraph 10.05 (Claims) and replace Paragraph 10.05 (Claims) by reference with the Winchester City Code, Section 21-61 (Contractual Disputes), as amended and where the Winchester City Code does not specify in writing the Virginia Public Procurement Act (VPPA) §2.2-4363 shall apply, as amended. Under Winchester City Code 21-61(C), the Purchasing Agent will render such decision within thirty (30) days.

5. Add subparagraph 12.01(D), as follows:
"In accordance with Winchester City Code, Section 21-44, Contract Modification: A public contract may include provisions for modification of the contract during performance, but no fixed-price contract may be increased by more than twenty-five percent of the amount of the contract or ten thousand dollars ($10,000), whichever is greater, without the advance written approval of the City Council. In no event may the amount of any contract, without adequate consideration, be increased for any purpose, including, but not limited to, relief of an offeror from the consequences of an error in its bid or offer."

6. Add the following language to 14.02 (A3), as follows: "See Special Conditions, Section 4.02."

7. Delete paragraph 14.09

8. Add subparagraph 17.01 (B), as follows: "This section, or any other General Condition in conflict with Virginia Code §8.01-222 shall not supercede the Commonwealth of Virginia statutory notice provisions. Virginia Code §8.01-222 shall prevail under all circumstances.

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ITB #202004– Pennsylvania Avenue and Conway Wastewater Pump Stations Replacement

SPECIAL CONDITIONS

1. **SPECIFICATIONS**

Unless otherwise described in the Contract Documents, the following specifications and standards apply to this work:

1. International Building Code (latest edition)
2. City of Winchester – Public Services Standards Manual

2. **INSURANCE REQUIREMENTS – CITY OF WINCHESTER**

2.01 Before any work at the site is started, Contractor shall deliver to Owner, with a Copy to Engineer, an executed Certificate of Insurance. The Certificate shall indicate that the required insurance is in force and state that the policies will not be materially changed or canceled without a thirty (30) day advance notice by registered mail to Owner and Engineer. The representative signing the Certificate shall furnish evidence that he is authorized to so sign as well as his address and the name and address of the agency or agencies through which the insurance was obtained. Contractor shall take out and maintain the following insurance:

2.02 Contractor's Comprehensive General Liability (bodily injury and property damage) shall be provided for the following limits:

A. Combined single limit 5,000,000 dollars each occurrence
B. Combined single limit: 5,000,000 dollars annual aggregate
C. The general liability insurance shall include the following coverage:

1. Comprehensive Form
2. Premises - Operation
3. Explosion and Collapse Hazard
4. Underground Hazards
5. Products/Completed - Operations Hazards
6. Contractual Liability Insurance
7. Broad Form Comprehensive General Liability, Property Damage, including Completed Operations
8. Independent Contractors (Contractor's Protective Liability)
9. Personal Injury (all insuring agreements), Deleting the Employee Exclusion
10. If protection is under an umbrella policy, it shall not exclude any of the above items under the basic policy.

D. City of Winchester shall be named by endorsement as Additional Insured.

2.03 Contractor's Automobile Liability (bodily injury and property damage) shall be provided for the following limits:

A. Combined single limit: 1,000,000 dollars each occurrence

B. The Automobile Liability Insurance shall include the following coverage:

1. Comprehensive Form
2. Owned
3. Hired
4. Non-Owner

2.04 Contractor's Workers Compensation Insurance as required by Federal, State, and Municipal Laws for the protection of all Contractor's employees working on or in connection with the Project, including broad form, all state and voluntary compensation coverage, and employer's liability coverage with the following limits:

A. Bodily injury by accident 1,000,000 Dollars each accident

B. Bodily injury by disease 1,000,000 Dollars policy limit

C. Bodily injury by disease 1,000,000 Dollars for each employee

2.05 All insurers shall be licensed to conduct business in the Commonwealth of Virginia and all insurance companies are required to have an A.M. Best Company financial rating of A- or better.

2.06 Contractor shall require his insurance agent to certify on the insurance certificate that the insurance coverage specified by these specifications is fully in effect, both in scope and amount. If insurance coverage is effected with more than one company, the individual certificates shall identify the items of insurance which the individual companies cover. The insurance certificates shall contain a provision that the coverage afforded under the policies will not be canceled or materially changed unless at least a thirty (30) days prior written notice has been given to the Owner.

2.07 Left Intentionally Blank

2.08 Notification and Handling of an Insurance Claim:

The general contractor on any City construction project shall be responsible for ensuring that all matters concerning the completion of an assigned project, including but not limited to handling of insurance claims by third parties arising as a result of the acts and omissions of the general contractor or his subcontractors, are handled in a professional manner. To this end, the City expects the general contractor to act responsibly with regard to prompt payment of valid insurance claims and upon notice of a claim, the general contractor shall immediately notify the Owner’s project manager, investigate and document the claim, and make a liability determination within ten (10) business days. Pending subrogation between the general contractor and/or sub-contractor and/or any insurance carrier will not be a cause for delay in payment of a valid claim. Default of this provision may result in retainage payments

being withheld and jeopardize the general contractor's future bid opportunities with the City of Winchester.

3. **WORKING HOURS - HOLIDAYS**

Work under the Contract shall not be prosecuted on Sundays, or on legal holidays. Work hours (Monday – Saturday) shall be from 7:00 a.m. until 6:00 p.m. If the Contractor wishes to prosecute any portion of the Work outside of the established work hours or on Sundays or legal holidays, he shall first obtain written permission from the Engineer. Such requests shall be submitted at least 48 hours in advance of the period proposed for such overtime work. For the purpose of this Contract, the legal holidays are identified as:

- Memorial Day (May 25, 2020)
- Independence Day (July 4, 2020)
- Labor Day (September 7, 2020)
- Columbus Day (October 12, 2020)
- Veteran's Day (November 11, 2020)
- Thanksgiving Day (November 26, 2020)
- Day after Thanksgiving (November 27, 2020)
- Christmas Eve observed (December 24, 2020)
- Christmas Day (December 25, 2020)
- New Year's Day (January 1, 2021)
- MLK Day (January 18, 2021)
- President's Day (February 15, 2021)

4. **PROGRESS PAYMENTS**

4.01 The basis for payments shall be the actual quantity of work completed, as determined in field by the Engineer.

4.02 An amount equal to five percent (5%) of each progress payment shall be held from each payment as retainage.

5. **MISCELLANEOUS OTHER CONDITIONS**

5.01 It shall be the responsibility of the Contractor to locate utilities in the field. Contractor shall give all utility companies that may have subsurface or surface utilities in the area adequate notice at least 48 hours in advance that the Contractor is to perform work in this area.

5.02 The attention of the Contractor is drawn to the fact that the possibility exists of the Contractor encountering various water, chemical, electrical, or other lines. Contractor shall exercise extreme care before and during construction to locate and flag these items so as to avoid damage to existing lines. Should damage occur to an existing line, the Contractor shall repair the line at no cost to the Owner. Temporary support, adequate protection and maintenance of all underground and surface utility installations and structures, drains, and other obstructions encountered in the progress

of the work shall be provided by the Contractor at his own expense.

5.03 Contractor shall be responsible for the temporary removal and re-installation of structures including, but not limited, to piping, conduits, drains, that may interfere with the work. The cost of such work shall be included in the Bid for the project and shall not result in any additional cost to the Owner. It shall be the Contractor's responsibility to contact and obtain permission from various authorities having jurisdiction over such structures, prior to start of the work.

5.04 Local drainage is not to be blocked. Shoulders, ditches, and drainage facilities shall be kept clear at all times and in condition satisfactory to the Engineer.

5.05 Adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the course of the work, and until it is safe for the pedestrian and vehicular traffic to use the area. The rules and regulations of the Local and State and Federal authorities respecting safety provisions shall be observed.

5.06 All acceptance and payment of work is subject to inspection by the City of Winchester.

5.07 The Contractor shall be responsible to establish and maintain communications with the residents and business owners of the area affected by the construction. The purpose of this communication is to notify the residents and business owners of construction activities which affect them, and to coordinate accommodations for them during construction. The Contractor shall also be required to assist businesses and residents as necessary with access into or out of their property during the construction.

5.08 Contractor and all sub-contractors shall obtain a City of Winchester Business License before beginning work.

5.09 Contractor is responsible for correcting any damages caused to private property as a result of construction, at their own expense. Contractor shall be responsible for completing a video recording (DVD) of the entire project area within the City's right-of-way before construction begins and providing a copy of the DVD to the City. This recording must be completed before the mobilization fee is paid to the contractor. This recording will be the basis for help in determining any damages to private property that may occur during construction that the contractor may be responsible for.

5.10 The Contractor shall be solely responsible for adhering to all OSHA requirements at all times during the construction of the project.

5.11 The Contractor shall be solely responsible for protecting the newly poured sidewalks from vandalism (i.e. children writing names or words in the wet concrete) and shall be required to replace any concrete that is vandalized as directed by the City at the

Contractor's expense.

5.12 The Contractor shall be responsible to construct the new facilities and/or modify existing facilities to ensure positive drainage at all locations.

5.13 High-early strength concrete shall be used on all driveway entrances.

5.14 The Contractor shall be solely responsible for ensuring that all new sidewalks and ramps constructed meet all current ADA (American's with Disabilities Act) requirements.

*****END SPECIAL CONDITIONS*****

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SECTION 01010

SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Work to be done under these Contracts and in accordance with these Specifications consists of furnishing all equipment, superintendence, labor, skill, material and all other items necessary to the construction of new Pennsylvania Pump Station and Conway Pump Station.

The Contractor shall perform all work required for such construction in accordance with the Contract Documents and subject to the terms and conditions of the Contract, complete and ready for use.

B. The Work to be performed under these Contracts includes: furnishing and installing a complete new Pennsylvania Avenue wastewater pump station and a complete new Conway wastewater pump station, demolition of existing facilities, connections to existing utilities, materials, equipment, installation, construction, testing and commissioning. The new pump stations shall be submersible style pump stations including wet wells, valve vault, emergency bypass connections, new emergency generator and fuel tank, associated electrical and controls as well as HVAC appurtenances on the pump station site and inside prefabricated electrical buildings. Each of the sites shall include new potable water service, existing gravity sewer modifications, new manholes, electrical service modifications, and related site work.

C. The foregoing description(s) shall not be construed as a complete description of all work required.

1.02 CONTRACT DOCUMENTS

A. The Work to be done is shown on the Set of Drawings entitled Pennsylvania Avenue and Conway Street Wastewater Pump Stations Replacement and dated October 2019. All drawings so enumerated shall be considered an integral part of the Contract Documents as defined herein.

1.03 CONSTRUCTION PERMITS, EASEMENTS AND ENCROACHMENTS

A. The Owner shall obtain or cause to be obtained all permanent easements as shown on the Drawings. The Contractor shall verify that these agreements have been obtained and shall comply with the conditions set forth in each agreement.

B. The Contractor shall obtain, keep current and pay all fees for any necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract

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limits and which will be occupied, encountered, used, or temporarily interrupted by the Contractor's operations unless otherwise stated. Record copies of all permits shall be furnished to the Engineer.

C. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the Contractor's responsibility to familiarize himself and comply with such regulations or requirements as they apply to his operations on this Project.

1.04 ADDITIONAL ENGINEERING SERVICES

A. In the event that the Engineer is required to provide additional engineering services as a result of substitution of materials or equipment which are not "or equal" by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.

B. Structural design shown on the Contract Drawings is based upon typical weights for major items of equipment as indicated on the Contract Drawings and specified. If the equipment furnished exceeds the weights of said equipment, the Contractor shall assume the responsibility for all costs of redesign and for any construction changes required to accommodate the equipment furnished, including the Engineer's expenses in connection therewith.

C. In the event that the Engineer is required to provide additional engineering services as a result of Contractor's errors, omissions, or failure to conform to the requirements of the Contract Documents, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.

1.05 ADDITIONAL OWNER'S EXPENSES

A. In the event the Work of this Contract is not completed within the time set forth in the Contract or within the time to which such completion may have been extended in accordance with the Contract Documents, the additional engineering or inspection charges incurred by the Owner may be charged to the Contractor and deducted from the monies due him. Extra work or supplemental Contract work added to the original Contract, as well as extenuating circumstances beyond the control of the Contractor, will be given due consideration by the Owner before assessing engineering and inspection charges against the Contractor.

B. Charges assessed to the Contractor for additional engineering and inspection costs will be determined based on actual hours charged to the job by the Engineer. Daily rates will depend on the number and classifications of employees involved.

C. Charges for additional Owner's expenses shall be in addition to any liquidated damages assessed in accordance with the Contract.

1.06 TIME OF WORK

A. The normal time of work for this Contract shall be as specified in the Supplemental Conditions. The Contractor may elect to work beyond these hours or on weekends provided that all costs incurred by the Owner for additional engineering and inspections shall be borne by the Contractor.

1. The Owner shall deduct the cost of additional engineering costs from monies due the Contractor.

B. Work shall be in accordance with the City of Winchester noise ordinance.

C. If it shall become imperative to perform work at night, the Owner and Engineer shall be informed a reasonable time in advance of the beginning of such work. Temporary lighting and all other necessary facilities for performing and inspecting the work shall be provided and maintained by the Contractor.

D. Unless otherwise specifically permitted, all work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work as will not suffer injury to workmanship or materials will be permitted. Contractor shall carefully protect his work against damage or injury from the weather, and when work is permitted during freezing weather, he shall provide and maintain approved facilities for heating the materials and for protecting the finished work.

1.07 SURVEYS AND LAYOUT

A. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings or as directed by the Engineer. Elevation of existing ground and appurtenances are believed to be reasonably correct but are not guaranteed to be absolute and therefore are presented only as an approximation. Any error or apparent discrepancy in the data shown or omissions of data required for accurately accomplishing the stake out survey shall be referred immediately to the Engineer for interpretation or correction.

B. All survey work for construction control purposes shall be made by the Contractor at his expense. The Contractor shall provide a Licensed Surveyor as Chief of Party, competently qualified men, all necessary instruments, stakes, and other material to perform the work.

C. Contractor shall establish all baselines for the location of the principal component parts of the work together with a suitable number of bench marks and batter boards adjacent to the work. Based upon the information provided by the Contract Drawings, the Contractor shall develop and make all detail surveys necessary for construction, including slope stakes, batter boards, stakes for all working points, lines and elevations.

D. Contractor shall have the responsibility to carefully preserve the bench marks, reference points and stakes, and in the case of destruction thereof by the Contractor or resulting from his negligence, the Contractor shall be charged with the expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points and stakes.

E. Existing or new control points, property markers and monuments that will be or are destroyed during the normal causes of construction shall be reestablished by the Contractor and all reference ties recorded therefore shall be furnished to the Engineer. All computations necessary to establish the exact position of the work shall be made and preserved by the Contractor.

F. The Engineer may check all or any portion of the work and the Contractor shall afford all necessary assistance to the Engineer in carrying out such checks. Any necessary corrections to the work shall be immediately made by the Contractor. Such checking by the Engineer shall not relieve the Contractor of any responsibilities for the accuracy or completeness of his work.

G. At completion of the work, the Contractor shall furnish Record Drawings indicating the final layout of all structures, roads, all structures, existing bench marks, etc. The Record Drawings shall indicate all critical elevations of and dimensions, piping, structures, finish grades, etc.

H. Contractor shall have the new pump stations surveyed by a licensed land surveyor. A final report showing all specified and surveyed elevations shall be certified by a licensed land surveyor and delivered to the Engineer.

1.08 FIRE PROTECTION

A. Contractor shall take all necessary precautions to prevent fires at or adjacent to the work, buildings, etc., and shall provide adequate facilities for extinguishing fires which do occur.

B. When fire or explosion hazards are created in the vicinity of the work as a result of the locations of fuel tanks, or similar hazardous utilities or devices, the Contractor shall immediately alert the local Fire Marshal, the Engineer, and the Owner of such tank or device. The Contractor shall exercise all safety precautions and shall comply with all instructions issued by the Fire Marshal and shall cooperate with the Owner of the tank or device to prevent the occurrence of fire or explosion.

1.09 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of either the EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable rules and regulations.

1.10 FIRST AID FACILITIES AND ACCIDENTS

A. First Aid Facilities

1. The Contractor shall provide at the site such equipment and facilities as are necessary to supply first aid to any of his personnel who may be injured in connection with the work.

B. Accidents

1. The Contractor shall promptly report, in writing, to the Engineer and Owner all accidents whatsoever out of, or in connection with, the performance of the work, whether on or adjacent to the site, which cause death, personal injury or property damage, giving full details and statements of witnesses.

2. If death, serious injuries, or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Owner and the Engineer.

3. If any claim is made by anyone against the Contractor or a Subcontractor on account of any accidents, the Contractor shall promptly report the facts, in writing, to the Engineer and Owner, giving full details of the claim.

1.11 BLASTING AND EXPLOSIVES

A. The use of blasting or explosives shall not be allowed under this project.

1.12 LIMITS OF WORK AREA

A. The Contractor shall confine his construction operations within the Contract limits shown on the Drawings and/or property lines and/or easement lines. Storage of equipment and materials, or erection and use of sheds outside of the Contract limits, if such areas are the property of the Owner, shall be used only with the Owner's approval.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Items listed in this Section, beginning with Article 1.4, refer to and are the same pay items listed in the Bid Form. They constitute all pay items for completing the Work. No direct or separate payment will be made for providing miscellaneous temporary or accessory works, plant services, field offices, layout surveys, Project signs, sanitary requirements, testing, safety devices, submittals and record drawings, water supplies, power and fuel, traffic maintenance, removal of waste, security, coordination with Owner's operations, bonds, insurance, or all other requirements of the General Conditions, Supplementary Conditions, General Requirements, and other requirements of the Contract Documents. Compensation for all services, items, and products shall be included in prices stipulated for lump sum and unit price pay items listed in this Section and included in the Contract.

B. Each lump sum and unit bid price shall be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

1.02 ENGINEER'S ESTIMATE OF QUANTITIES

A. Engineer's estimated quantities for unit price items, as listed in the Bid Form, are approximate only and are included solely for the purpose of comparing Bids. Owner does not expressly or by implication agree that the nature of materials encountered below ground surface or actual quantities of material encountered or required shall correspond with quantities on the Bid Form, and reserves the right to increase or decrease quantities or to eliminate quantities as Owner may deem necessary. Contractor shall not be entitled to adjustment in a unit bid price as a result of change in an estimated quantity and agrees to accept the unit prices bid as complete and total compensation for additions or deductions caused by changes or alterations in the Work directed by Owner.

1.03 RELATED PROVISIONS

A. Payments to Contractor: Refer to General Conditions, Supplementary Conditions, and Agreement.

B. Changes in Contract Price: Refer to General Conditions and Supplementary Conditions.

C. Schedule of Values: Refer to General Conditions, Supplementary Conditions.

1.04 BID ITEMS

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A. Item 1 – For Contract Work:
   1. Measurement and Payment: The Lump Sum payment for Item 1 will be full compensation for completing the Work, as shown and specified in the Contract Documents and as summarized in Section 01110 – Summary of Work, including but not limited to all excavation required to meet grades as shown on the Drawings, haul-off, disposal, demolition and temporary facilities, with the exception of the additional work items that Contractor may be ordered by Owner or Engineer to perform which are as listed in Items 2-6 below.

B. Item 2 – Additional Excavation
   1. Measurement: The quantity of additional excavation including disposal of unsuitable materials will be measured for payment on the basis of lines and grades ordered by Owner or Engineer in writing, or as volume within limits described below, whichever is applicable.
      a. Excavation as required for structures or facilities will be measured for payment to subgrade directed for such excavation and, unless otherwise shown, to vertical planes one foot outside foundation limits of structure to be built therein.
      b. Measurement of actual quantities will be made by Owner or Engineer. Contractor may, at his expense, verify quantities.
   2. Payment: Unit price for Item 2 will be full compensation for all additional excavation, including disposal, complete as directed by Owner or Engineer and not specifically included under other items.

C. Item 3 - Additional Backfill with VDOT 21A Stone
   1. Measurement: The quantity of additional crushed stone consisting of VDOT No. 21A Stone that will be paid under this item will be the computed number of cubic yards placed and compacted within limits shown, specified or directed by Owner or Engineer in writing.
   2. Payment: Unit price for Item 3 will be full compensation for providing, placing, compacting, and testing all additional crushed stone or gravel complete as shown, specified, or directed by Owner or Engineer in writing

E. Item 4 – Additional Pavement Milling and Overlay (1-1/2” Depth)
   1. Measurement: The quantity of additional pavement milling and overlay that will be paid under this item will be the number of square feet placed within limits shown, specified or directed by Owner or Engineer in writing.
   2. Payment: Unit price for Item 4 will be full compensation for pavement milling and overlay complete as shown, specified, or directed by Owner or Engineer in writing

F. Item 5 – Emergency Bypass Pumping System Installation and Removal
   1. Measurement and Payment: The Lump Sum payment for Item 5 will be full compensation for the installation and removal of an emergency bypass pumping system in accordance with Section 01525 as directed by Owner or Engineer.

G. Item 6 – Emergency Bypass Pumping System Operation

1. Measurement and Payment: The payment for Item 6 will be full compensation for Monthly operation of an emergency bypass pumping system in accordance with Section 01525 as directed by Owner or Engineer.

H. Item 7 – Allowance
   1. Measurement and Payment: The Lump Sum payment for Item 7 will be full compensation for SCADA Programming Work.

PART 1 – PRODUCTS

(NOT USED)

PART 1 – EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01040

COORDINATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall allow the Owner or his agents, and other project Contractors or their agents, to enter upon the work for the purpose of constructing, operating, maintaining, removing, repairing, altering, or replacing such pipes, sewers, conduits, manholes, wires, poles, or other structures and appliances which may be required to be installed at or in the work. The Contractor shall cooperate with all aforesaid parties and shall allow reasonable provisions for the prosecution of any other work by the Owner, or others, to be done in connection with his work, or in connection with normal use of the facilities.

B. Each Contractor shall cooperate fully with the Owner, the Engineer, and all other Contractors employed on the work, to effect proper coordination and progress to complete the project on schedule and in proper sequence. Insofar as possible, decisions of all kinds required from the Engineer shall be anticipated by the Contractor to provide ample time for inspection, or the preparation of instructions.

C. Each Contractor shall assume full responsibility for the correlation of all parts of his work with that of other Contractors. Each Contractor's superintendent shall correlate all work with other Contractors in the laying out of work. Each Contractor shall lay out his own work in accordance with the Drawings, Specifications, and instructions of latest issue and with due regard to the work of other Contractors.

D. Periodic coordinating conferences shall be held per Section 01200, Project Meetings, of these Contract Documents.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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- END OF SECTION -

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SECTION 01070

ABBREVIATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The following is a partial list of typical abbreviations which may be used in the Specifications, and the organizations to which they refer:

AASHTO	-	American Association of State Highway and Transportation Officials
ACI	-	American Concrete Institute
ACIFS	-	American Cast Iron Flange Standards
AFBMA	-	Anti-Friction Bearing Manufacturer's Association
AGA	-	American Gas Association
AGMA	-	American Gear Manufacturers Association
AIA	-	American Institute of Architects
AISC	-	American Institute of Steel Construction
AISI	-	American Iron and Steel Institute
ANSI	-	American National Standard Institute
API	-	American Petroleum Institute
ASCE	-	American Society of Civil Engineers
ASHRAE	-	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society for Testing and Materials
AWS	-	American Welding Society
AWWA	-	American Water Works Association
CEMA	-	Conveyor Equipment Manufacturer's Association
CRSI	-	Concrete Reinforcing Steel Institute
DIPRA	-	Ductile Iron Pipe Research Association
Fed Spec	-	Federal Specifications
FRPI	-	Fiberglass Reinforced Plastics Institute
IEEE	-	Institute of Electrical and Electronic Engineers
IPCEA	-	Insulated Power Cable Engineers Association
ISO	-	Insurance Services Offices
NBS	-	National Bureau of Standards
NEC	-	National Electric Code
NEMA	-	National Electrical Manufacturers Association
NSF	-	NSF International
OSHA	-	Occupational Safety and Health Act
PCI	-	Precast Concrete Institute
UL	-	Underwriters Laboratories, Inc.
USGS	-	United States Geological Survey
VDH	-	Virginia Department of Health

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VDOT - Virginia Department of Transportation

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01090

REFERENCE STANDARDS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Wherever reference is made to any published standards, codes, or standard specifications, it shall mean the latest standard code, specification, or tentative specification of the technical society, organization, or body referred to, which is in effect at the date of invitation for Bids.

B. All materials, products, and procedures used or incorporated in the work shall be in strict conformance with applicable codes, regulations, specifications, and standards.

C. A partial listing of codes, regulations, specifications, and standards includes the following:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Bearing Manufacturers' Association
ACI	American Concrete Institute
AEIC	Association of Edison Illuminating Companies
AGA	American Gas Association
AGMA	American Gear Manufacturers' Association
AI	Asphalt Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction

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ALS	American Lumber Standards
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
APA	APA – The Engineered Wood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASSE	American Society of Sanitary Engineering
ASTM	ASTM International
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers' Association
AWPI	American Wood Preservers' Institute
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers' Association
CBM	Certified Ballast Manufacturer
CDA	Copper Development Association
CGA	Compressed Gas Association

CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers' Association of America
COE	U.S. Army Corps of Engineers
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standard
CSA	Canadian Standards Association
CSI	Construction Specifications Institute
DEQ	Virginia Department of Environmental Quality
DIPRA	Ductile Iron Pipe Research Association
EIA	Electronic Industries Alliance
EJCDC	Engineers Joint Contract Documents' Committee
EPA	United States Environmental Protection Agency
ETL	Electrical Test Laboratories
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FIPS	Federal Information Processing Standards
FM	Factory Mutual
Fed. Spec.	Federal Specifications (FAA Specifications)
FS	Federal Specifications and Standards (Technical Specifications)
GA	Gypsum Association
GANA	Glass Association of North America
HI	Hydraulic Institute
HMI	Hoist Manufacturers' Institute

IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
ICEA	Insulated Cable Engineers' Association
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
IFI	Industrial Fasteners Institute
IGMA	Insulating Glass Manufacturer's Alliance
IMC	International Mechanical Code
INDA	Association of the Nonwoven Fabrics Industry
IPC	International Plumbing Code
ISA	Instrumentation, Systems, and Automation Society
ISO	International Organization for Standardization
ITL	Independent Testing Laboratory
JIC	Joint Industry Conferences of Hydraulic Manufacturers
MIA	Marble Institute of America
MIL	Military Specifications
MMA	Monorail Manufacturers' Association
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International
NBGQA	National Building Granite Quarries Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractor's Association

NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NHLA	National Hardwood Lumber Association
NICET	National Institute for Certification in Engineering Technologies
NIST	National Institute of Standards and Technology
NRCA	National Roofing Contractors Association
NRTL	Nationally Recognized Testing Laboratories
NSF	NSF International
NSPE	National Society of Professional Engineers
NTMA	National Terrazzo and Mosaic Association
NWWDA	National Wood Window and Door Association
OECI	Overhead Electrical Crane Institute
OSHA	Occupational Safety and Health Act (both Federal and State)
PCI	Precast/Prestressed Concrete Institute
PEI	Porcelain Enamel Institute
PPI	Plastic Pipe Institute
PS	Product Standards Section-U.S. Department of Commerce
RMA	Rubber Manufacturers' Association
RUS	Rural Utilities Service
SAE	Society of Automotive Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute
SJI	Steel Joist Institute

SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPI	Society of the Plastics Industry
SSPC	The Society for Protective Coatings
SWI	Steel Window Institute
TEMA	Tubular Exchanger Manufacturers' Association
TCA	Tile Council of North America
TIA	Telecommunications Industry Association
UBC	Uniform Building Code
UFC	Uniform Fire Code
UL	Underwriters Laboratories Inc.
UMC	Uniform Mechanical Code
USBR	U.S. Bureau of Reclamation
USDA	United States Department of Agriculture
VDH	Virginia Department of Health
VDOT	Virginia Department of Transportation
VMRC	Virginia Marine Resources Commission
VPDES	Virginia Pollutant Discharge Elimination System
VUSBC	Virginia Uniform Statewide Building Code
WCLIB	West Coast Lumber Inspection Bureau
WIC	Wood Institute of California
WWPA	Western Wood Products Association

D. Contractor shall, when required, furnish evidence satisfactory to the Engineer that materials and methods are in accordance with such standards where so specified.

E. In the event any questions arise as to the application of these standards or codes, copies shall be supplied on-site by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01200

PROJECT MEETINGS

PART 1 -- GENERAL

1.01 PRE-BID MEETING

A. A pre-bid meeting will be held at the time and place to be designated in the Instructions to Bidders.

B. The Engineer will be available to discuss the project and answer pertinent questions. No oral interpretation will be made as to the meaning of the Documents. Interpretation, if deemed necessary by the Engineer, will be in the form of an Addendum to the Contract Documents.

1.02 PRECONSTRUCTION MEETING

A. A preconstruction meeting will be held after Award of Contract, but prior to starting work at the site.

B. Attendance:

1. Owner
2. Engineer
3. Contractor
4. Major subcontractors
5. Safety representative
6. Representatives of governmental or other regulatory agencies.

C. Minimum Agenda:

1. Tentative construction schedule
2. Critical work sequencing
3. Designation of responsible personnel
4. Processing of Field Decisions and Change Orders
5. Adequacy of distribution of Contract Documents

110209BR

6. Submittal of Shop Drawings and samples

7. Procedures for maintaining record documents

8. Use of site and Owner's requirements

9. Major equipment deliveries and priorities

10. Safety and first aid procedures

11. Security procedures

12. Housekeeping procedures

13. Processing of Partial Payment Requests

14. General regard for community relations

1.03 PROGRESS MEETING

A. Progress meetings will be held monthly during the performance of the work of this Contract. Additional meetings may be called as progress of work dictates.

B. Engineer will preside at meetings and record minutes of proceedings and decisions. Engineer will distribute copies of minutes to participants.

C. Attendance:

1. Engineer

2. Owner

3. Contractor

4. Subcontractors, only with Engineer's approval or request, as pertinent to the agenda

D. Minimum Agenda:

1. Review and approve minutes of previous meetings.

2. Review progress of Work since last meeting.

3. Review proposed 30-60 day construction schedule.

4. Note and identify problems which impede planned progress.

5. Develop corrective measures and procedures to regain planned schedule.

6. Revise construction schedule as indicated and plan progress during next work period.

7. Maintaining of quality and work standards.

8. Complete other current business.

9. Schedule next progress meeting.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01300

SUBMITTALS

PART 1 – GENERAL

1.01 GENERAL

A. This section covers the requirements for technical and administrative submittals.

1.02 SUBMITTAL PROCEDURES

A. Unless otherwise specified, all submittals:

1. Shall be made in accordance with the Schedule of Submittals.

2. Submittal comments will be returned by the Engineer or Owner with comments or other necessary response within thirty (30) days after receipt by the Owner.

3. Submittals shall consist of .pdf files to Engineer and Owner. The submittals shall be delivered to the Owner and Engineer on CD ROM. Paper copies of certain submittals are required as specified herein.

B. Certain submittals require extended review times or special submittal procedures as specified. The Owner reserves the right to modify the procedures and requirements for submittals, as necessary to accomplish the specific purpose of each submittal. Contractor shall direct inquiries to Engineer regarding the procedure, purpose, or extent of any submittal.

C. Review, acceptance, or approval of substitutions, schedules, Shop Drawings, O&M manuals, lists of materials, or procedures submitted or requested by Contractor shall not add to the Contract Price or Contract Time, and additional costs or time which may result therefrom shall be solely the obligation of Contractor. Owner is not responsible to provide engineering or other services to protect Contractor from additional costs accruing from such approvals.

1.03 PROGRESS SCHEDULE

A. Submit Progress schedule in accordance with the requirements of Section 01320 Progress Schedule

1.04 SCHEDULE OF SUBMITTALS

A. The Contractor shall prepare and submit a schedule of all submittals (submittal log) required by the Contract Documents in a format provided by the Engineer or Owner. Each submittal is to be identified by applicable Specification section number and a brief

description of the submittal subject and content. Contractor shall furnish this schedule within 15 days of Notice to Proceed for review by the Engineer. Revisions and additions to the schedule shall be made as and when required by the Engineer.

B. All submittals required by the Contract Documents shall be identified as separate schedule activities and included on the Project Schedule.

C. Allowances or contingency for all submittal requirements including re-submittals shall be factored into the Project Schedule and shown as separate schedule activities.

D. The Contractor shall maintain and update the Schedule of Submittals /submittal log, showing current status of submittals. The submittal log shall have the following items listed, as a minimum:

1. Submittal's subject and content.

2. Submittals and resubmittals number with corresponding dates.

3. Engineer's disposition with corresponding date.

4. Brief comments.

E. Submit updated submittal log monthly at the progress meetings and as requested for review by the Owner and Engineer.

1.05 ADMINISTRATIVE SUBMITTALS

A. Contractor shall provide administrative submittals required by the Contract Documents.

B. Contractor shall provide copies of all permits and permit closeouts.

C. Contractor shall make required submittals promptly to the applicable federal, state, or local agency, as required by law. Failure to comply with this requirement may result in withholding of partial payments and make Contractor liable for other prescribed action and sanctions.

D. Contractor shall submit to Owner a copy of letters relative to the Contract, including notifications, reports, certifications, payrolls, and the like, that are submitted directly to a federal, state, or other governing agency.

E. Acceptance by Owner of Project Schedule, Schedule of Submittals, and Schedule of Values are a condition precedent to the Owner considering any Payment Application from the Contractor.

1.06 SHOP DRAWINGS

A. Shop Drawings include, but are not limited to layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc. Contractor shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Shop Drawings

required and necessary under this Contract and to fulfill all other requirements of his Contract.

B. Shop Drawings and Product Data: Unless otherwise directed in writing, the Contractor shall deliver five (5) hard copies of all submittals to the Engineer and two (2) copies to the Owner.

C. Contractor shall submit for review by the Engineer Shop Drawings for all fabricated work and for all manufactured items required to be furnished by the Contract Documents.

D. Structural and all other layout Drawings prepared specifically for the Project shall have a plan scale of not less than 1/4-inch = 1 foot.

E. Where manufacturer's publications in the form of catalogs, brochures, illustrations or other data sheets are submitted in lieu of prepared Shop Drawings, such submittals shall clearly and specifically indicate the item and item options for which approval is requested. Identification of items shall be made in ink, and submittals showing only general information are not acceptable.

F. Layout and Installation Drawings

1. Contractor shall prepare and submit for review by the Engineer layout and installation drawings for all electrical conduits, ducts, pipes, valves, fittings, heating and ventilation ducts and pipes, equipment, lighting fixture layouts, and circuiting, instrumentation, interconnection wiring diagrams, communications, power supply, alarm circuits, ductwork, electrical cable trays, etc., under this Contract. The final dimensions, elevation, location, etc., of pipe, valves, fittings, conduits, equipment, ducts, etc., may depend upon the dimensions of equipment and valves to be furnished by the Contractor.

2. Layout and installation Drawings shall show details of connections to structures, equipment, sleeves, valves, fittings, etc.

3. Layout and installation Drawings shall show the location and type of all supports, hangers, foundations, etc., and the required clearances to operate valves, equipment, etc.

4. Layout and installation Drawings shall show all structures, manholes etc. or any other feature within four (4) feet (measured as the clear dimension) from the pipe, duct, conduit, etc., which is the subject of the Layout and Installation Drawing.

G. Contractor Responsibilities

1. All submittals from subcontractors, manufacturers or suppliers shall be sent directly to the Contractor for review. Contractor shall thoroughly check all Drawings for accuracy and conformance to the intent of the Contract Documents. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors, manufacturers, or suppliers by the Contractor for correction before submitting to them to the Engineer.

2. All submittals shall be organized, dated, properly labeled and consecutively numbered. Information on the cover sheet/label shall indicate Specification Section, Drawing number, subcontractor's, manufacturer's or supplier's name and the name or type of item the submittal covers. Each part of a submittal shall be marked and tabulated.

3. Working Drawings shall be submitted as a single complete package including all associated drawings relating to a complete assembly of the various parts necessary for a complete unit or system.

4. Shop Drawings shall be submitted as a single complete package for any operating system and shall include all items of equipment and any mechanical units involved or necessary for the functioning of such system. Where applicable, the submittal shall include elementary wiring diagrams showing circuit functioning and necessary interconnection wiring diagrams for construction.

5. All submittals shall be thoroughly reviewed by the Contractor for accuracy and conformance to the intent of the contract documents before being submitted to the engineer and shall bear the Contractor's acknowledgement certifying that they have been so reviewed (either in the submittal itself, or in the Contractor's transmittal of such submittal). Submittals without the Contractor's acknowledgement of approval will not be reviewed by the Engineer and will be returned to the Contractor.

6. If the submittals contain any departures from the Contract Documents, specific mention thereof shall be made in the Contractor's letter of transmittal. The review of submittals provided without clear annotation of any proposed departure from the contract requirements shall not constitute approval of the departure.

7. No materials or equipment shall be ordered, fabricated or shipped or any associated work performed until the Engineer returns to the Contractor the submittals, herein required, annotated to indicate that the materials or equipment are satisfactory as indicated by submittals annotated Furnish as Submitted or Furnish as Corrected.

8. Where errors, deviations, and/or omissions are discovered at a later date in any of the submittals, the Engineer's prior review of the submittals does not relieve the Contractor of the responsibility for correcting all errors, deviations, and/or omissions.

9. A 10-character submittal identification numbering system shall be used:

   a. The first character shall be an alpha character as follows:

      D - Shop Drawings

      P - Product Data

L - Layout and Installation Drawings

M - Operation and Maintenance Manual

R - Certification, Test Results, and ISA Forms

S - Sample

U - Test Procedures

b. The next five digits shall be the applicable Specifications Section Number.

c. The next three digits shall be the numbers 001-999 to sequentially number each separate item or drawing submitted under each Specification Section.

d. The last character shall be a letter, A-Z, indicating the submission, or resubmission of the same Drawing, i.e., A-1st submission, B-2nd submission, C-3rd submission, etc. A typical submittal number would be as follows:

D-15260-008-B

D	=	Shop Drawing
15260	=	Specification Section for Insulation
008	=	The eighth sequential submittal under this specification section
B	=	The second submission (first resubmission) of that particular Shop Drawing.

e. NOTE: The grouping of data under a general specification section rather than the specific section in which it is referenced is prohibited. (Such as including all electrical submittals in one package with a common submittal number D-16000-001-A.) If data from more than one section is submitted simultaneously, one submittal number will be assigned for each relevant specification section.

H. Procedure for Review

1. Submittals shall be transmitted in sufficient time to allow the Engineer at least thirty (30) working days for review and processing.

2. Submittal shall be accompanied by a letter of transmittal, in duplicate, containing date, project title, Contractor's name, number and titles of submittals, notification of departures and any other pertinent data to facilitate review.

3. Submittals will be annotated by the Engineer in one of the following ways:

   a. "Furnish as Submitted" - no exceptions are taken.

   b. "Furnish as Corrected" - minor corrections are noted and shall be made.

   c. “Furnish as Corrected– Confirm” - some corrections are noted and a partial resubmittal or additional information is required as specifically requested.

   d. "Revise and Resubmit" (R&R) - major corrections are noted and a full resubmittal is required.

   e. "Receipt Acknowledged” (RA) – submittal was received and was distributed for record purposes without review.

   f. “Rejected” (R) - Based on the information submitted, the submission is not in conformance with the Contract Documents. The deviations from the Contract Documents are too numerous to list and a completely revised submission of the proposed equipment or a submission of other equipment is required.

4. If a submittal is satisfactory to the Engineer, the Engineer will annotate the submittal "Furnish as Submitted" or "Furnish as Corrected". Furnish as Corrected - Confirm” a partial resubmittal or additional information is required as specifically requested.

5. If a re-submittal is required, the Engineer will annotate the submittal "Revise and Resubmit".

6. Contractor shall revise and resubmit submittals as required by the Engineer until submittals are acceptable to the Engineer. The Contractor that Owner may charge the Contractor a fee for each submittal review beyond the first re-submittal in the event that a given submittal has not reached an approved status (either "Furnish as Submitted" or "Furnish as Corrected") after review of the first re-submittal. This fee in intended to cover the Owner’s costs associated with excess engineering reviews of submittals. Acceptance of a Working Drawing by the Engineer will constitute acceptance of the subject matter for which the Drawing was submitted and not for any other structure, material, equipment or appurtenances indicated or shown.

I. Engineer's Review

1. Engineer's review of the Contractor's submittals shall in no way relieve the Contractor of any of his responsibilities under the Contract. An acceptance of a submittal shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications.

2. Engineer's review will be confined to general arrangement and compliance with the Contract Drawings and Specifications only, and will not be for the purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of trades, etc.

J. Record Working Drawings

1. Prior to final payment, the Contractor shall furnish the Engineer one complete set of all accepted Working Drawings, including Shop Drawings, for equipment, piping, electrical work, heating and ventilation equipment, instrumentation system, structural, interconnection wiring diagrams, etc.

2. Manufacturer's publications, submitted in lieu of prepared Shop Drawings, will not be required in reproducible form.

3. Working Drawings furnished shall be corrected to include any departures from previously accepted Drawings. Working Drawings include, but are not limited to, Shop Drawings, layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc. Contractor shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Working Drawings required and necessary under this Contract and to fulfill all other requirements of his Contract. Contractor shall secure such information, details, Drawings, etc., from all possible sources including the Drawings, Working Drawings prepared by subcontractors, Engineers, suppliers, etc.

4. Working Drawings shall accurately and clearly present the following:

   a. All working and installation dimensions.

   b. Arrangement and sectional views.

   c. Units of equipment in the proposed positions for installation, details of required attachments and connections, and dimensioned locations between units and in relation to the structures.

   d. Necessary details and information for making connections between the various trades including, but not limited to, power supplies and interconnecting wiring between units, accessories, appurtenances, etc.

   e. Working drawings shall include coordination drawings of sufficient detail to indicate that all trades have coordinated their installation requirements such that interferences are avoided and proper space is allowed for installation and future access for maintenance.

5. Working Drawings specifically prepared for this Project shall be on mylar or other approved reproducible material sheets of the same size as the Drawings. Working

Drawings shall conform to recognized drafting standards and be neat, legible and drawn to a large enough scale to show in detail the required information.

1.07 SAMPLES AND TESTS SPECIMENS

A. Where required in the Specifications, and as determined necessary by Engineer, Contractor shall submit test specimens or samples of materials, appliances, and fittings to be used or offered for use in connection with the Work; include information as to their sources; prepay cartage charges; and submit such quantities and sizes for proper examination and tests to establish the quality or equality thereof, as applicable.

B. Contractor shall submit samples and test specimens in ample time to enable Engineer to make tests or examinations necessary, without delay to the Work.

C. Contractor shall submit additional samples as required by Engineer to ensure equality with the original approved sample and/or for determination of Specification compliance.

D. Laboratory tests and examinations that Owner elects to make in its own laboratory will be made at Owner's cost except that, if a sample of any material or equipment proposed for use by Contractor fails to meet the Specifications, Contractor shall bear cost of testing subsequent samples.

1. Tests required by the Specifications to be performed by an independent laboratory shall be made by a laboratory licensed or certified in accordance with state statutes at Contractor's cost.

2. Contractor shall submit certified test results of specified tests to Engineer.

3. Samples and laboratory services shall be at the expense of Contractor and included in the Contract for the associated Work.

E. Approved sample items (fixtures, hardware, etc.) may be incorporated into the Work when no longer needed by Engineer for reference.

F. Contractor shall furnish for review all samples as required by the Contract Documents or requested by the Engineer.

G. Samples shall be of sufficient size or quantity to clearly illustrate the quality, type, range of color, finish or texture and shall be properly labeled to show the nature of the material, trade name of manufacturer and location of the work where the material represented by the sample will be used.

H. Samples shall be checked by the Contractor for conformance to the Contract Documents before being submitted to the Engineer and shall bear the Contractor's stamp of approval certifying that they have been so checked. Transportation charges on samples submitted to the Engineer shall be prepaid by the Contractor.

I. Accepted samples will establish the standards by which the completed work will be judged.

1.08 QUALITY CONTROL SUBMITTALS

A. Manufacturer's Certificates of Proper Installation:

1. Manufacturer's Certificates of Proper Installation (MCPIs) shall be submitted by the Contractor for each piece of equipment provided under the Contract that includes an O&M Manual.

2. Each MCPI shall include the equipment name and Specification number, the equipment supplier or vendors name and contact information, and the date and signature of the representative certifying proper installation of the equipment.

3. Each MCPI shall include the list of specific items checked by the supplier/vendor's representative in the process of certifying proper installation of the equipment including, but not limited to the following:

a. The product or system has been installed in accordance with the manufacturer's recommendations.

b. The product or system has been inspected by a manufacturer's authorized representative and proper adjustments have been made.

c. The product or system has been maintained prior to and after installation in accordance with the Manufacturer's recommendations as evidenced by Service Records maintained by the Contractor.

d. Applicable safety equipment has been properly installed.

e. Proper electrical and mechanical connections have been made.

f. The product, subsystem, or system is ready for testing, startup, and operation.

1.09 OPERATION AND MAINTENANCE (O&M) MANUALS

A. General:

1. Approved O&M manuals shall be prepared and assembled for all equipment incorporated into the Work.

2. Assemble each O&M manual by Specification section unless otherwise approved by the Engineer.

3. Engineer will determine adequacy of each O&M manual as to content, organization, and quality. Prior approval of O&M manuals does not relieve the Contractor of the responsibility to revise and resubmit manuals, or portions of manuals, found to be missing or incomplete. If missing or incomplete information is found after an O&M manual is approved, submit new information in accordance

with this article. Submittal status may change after initial approval if prior submittal is found to be deficient after the initial approval.

B. Procedures:

1. Submission procedures for O&M manual submittals shall be the same as stated in Article 1.05, Shop Drawings, of this section, except for the provisions specified herein.

2. Contractor shall submit to Engineer searchable PDF format for review and approval in accordance with the accepted Schedule of Submittals.

3. When O&M manuals have been reviewed by Engineer, and corrections are required, the Contractor shall correct and resubmit O&M manuals in the same manner and quantity as specified for the original submittal. Re-submittal shall occur within 30 days following return to the Contractor.

4. When preliminary O&M manuals have been reviewed and approved by the Engineer, these submittals will constitute the final preliminary O&M manuals.

C. Preliminary Equipment O&M Manuals:

1. Each equipment O&M manual shall be complete in all respects for equipment, controls, accessories, components (e.g., motors, speed reducers, etc.), and associated appurtenances, including all Shop Drawing revisions, and shall include the following:

a. Diagrams and illustrations.

b. Detailed description of the function of each principal component of the system.

c. Performance and nameplate data of each component.

d. Name, address and telephone numbers of:

1) Manufacturer.

2) Manufacturer's local representative.

3) Nearest parts supply house.

4) Nearest repair service.

e. Installation instructions.

f. Procedure for starting.

g. Proper adjustment.

h. Test procedures and results of factory tests where required.

i. Procedure for operating, including both individual components and the entire system (where the manual is for a system).

j. Shutdown instructions for both short and extended durations.

k. Emergency operating instructions.

l. Troubleshooting guide including common problems, symptoms, causes and remedies.

m. Safety precautions.

n. Maintenance and overhaul instructions, illustrated with detailed assembly drawings clearly showing each part with part numbers and sequentially numbered parts list. Include instructions for ordering spare parts, and complete preventive maintenance and overhaul instructions required to ensure satisfactory performance and longevity of the equipment.

o. A current, dated, complete parts list.

p. Lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, quantity, and temperature range of lubricants and frequency of lubrication; including the identification of the appropriate lubricant(s).

q. List of electrical relay settings and control and alarm contact settings.

r. Electrical interconnection wiring diagram for equipment furnished, including all control and lighting systems.

s. Electrical control diagrams.

t. See Division 16, Electrical, for additional specific O&M manual requirements.

u. List of recommended spare parts, including the recommended quantity for the total number of pieces of equipment supplied for this Project.

v. List of spare parts and special tools actually provided for this Project and the retail value of same.

2. Manuals shall be customized to describe the equipment actually furnished and shall not include extraneous data for models, options, or sizes not furnished.

   a. Where more than one model, option, or size of an equipment type is furnished, the manual shall clearly indicate the information pertaining to each model, option, or size furnished.

   b. Manufacturer's preprinted literature may be accepted provided it has been customized to indicate clearly the models, options, and sizes actually furnished, and that equipment models not furnished have been clearly crossed out or deleted.

3. Material in manuals shall be suitable for photographic reproduction. Where copies of identical material are included, clarity and quality of copies shall equal the original.

D. Final Equipment O&M Manuals shall include approved preliminary O&M manual submittal in addition to:

1. Results of functional and performance tests as required under Article Contract Closeout Submittals, of this section. If the manual has already been approved, submit the items for insertion into the manual.

2. Copies of all warranties/guarantees, with warranty start date(s).

3. Approved shop drawings.

4. The final O&M manual shall be submitted after substantial completion.

5. Assembly:

   a. Contractor shall assemble each copy of the O&M manual into ACCO brand expandable binder in a color selected by the Owner and in a searchable PDF format.

   b. Contractor shall clearly label each binder to designate the system or equipment for which it is intended and the Specification section where the equipment is specified.

   c. Contractor shall provide each binder with title page, typed table of contents with page numbers, and heavy Mylar-coated section dividers with numbered plastic index tabs.

   d. O&M Manuals: Each binder shall be limited to 1 inch to 2 inch thick. If more space is required, the O&M manual shall be broken into more than one binder. Where more than one binder is required, they shall be labeled "Vol. 1," "Vol. 2," and so on. Contractor shall place the table of contents for the entire set, identified by volume number, in each binder.

e. Contractor shall punch all data for binding and composition, and arrange printing so that punching holes does not obliterate data.

1.10 SPARE PARTS AND SPECIAL TOOLS

A. Prior to Substantial Completion, the Contractor shall furnish spare parts data for each item of equipment as required in the respective Equipment Specifications Sections. The data shall include a complete list of parts and supplies, with current unit prices and source or sources of supply.

B. Contractor shall also furnish a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the Equipment or specified to be furnished as part of the Contract and a list of additional items recommended by the manufacturer to assure efficient operation through the Correction Period (warranty period) for the particular installation.

C. All parts shall be securely boxed and tagged, and clearly marked on the box and individually for identification as to the name of manufacturer or supplier, applicable Equipment, part number, description and location in the Equipment. All parts shall be protected and packaged for a shelf life of at least ten (10) years.

D. Contractor shall furnish at no additional cost to the Owner with each piece of Equipment as a minimum, one (1) complete set, or the number of sets called for in the Technical Specifications, of suitably marked special tools and appliances which may be needed to adjust, operate, maintain, or repair the Equipment.

E. Contractor shall submit, for approval by the Engineer, a complete list of the special tools and appliances to be furnished. Such tools and appliances shall be furnished in approved painted steel cases properly labeled and equipped with good grade cylinder locks and duplicate keys.

F. The spare parts and special tools shall be delivered and placed by the Contractor in a location designated by the Owner. The Contractor is advised that spare parts and special tools may be delivered to City's maintenance facilities and not the project site.

1.11 TESTING PLANS

A. Submit Testing Plans in accordance with Section 01650, Start-Up and Field Testing,

1.12 CONTRACT CLOSEOUT SUBMITTALS

A. Record Documents:

1. The Contractor shall maintain at the Site, a full-size, clean, undamaged set of Contract Drawings, and Shop Drawings as Record Drawings to document the installed Work and to be submitted to the Owner and approved as a condition precedent to Final Completion.

2. Record Drawings shall be kept up-to-date and maintained continuously throughout the duration of the Project, and shall include the configuration and location of concealed elements prior to their completion and subsequent concealment.

3. Accurately document the location of all buried utilities horizontally and vertically prior to burial. Buried utilities shall include pipelines, conduits, and duct banks. Locations shall include vertical and horizontal coordinates in the correct datum established for this Project. As a minimum, locate all utilities at all changes in direction and every 100 linear feet longitudinally. Reference locations to inverts of pipelines and bottoms of duct banks. Receive Engineer's verification of data collection and approval prior to covering any buried utilities.

4. Contractor certification and Engineer verification of monthly Record Drawing updates that accurately present the Work installed shall be a condition precedent to the Owner's obligation to make any partial payments.

5. Record Drawings shall be available for Engineer review at all times at the Site.

6. Record Drawings shall be marked to show actual installation where installation varies substantially from the Work shown on the Contract Drawings or where new information is provided.

7. Where Shop Drawings more accurately portray Work, record appropriate cross-references on the Contract Drawing portion of the Record Drawings.

8. Accurately present and annotate all applicable Requests for Information (RFI), and Changes in the Work (such as Change Orders, Work Orders, or Field Orders) on the Record Drawings. Maintain and submit with final Record Drawings a list of Drawings modified for each change.

9. Organize Record Drawings into manageable sets. Bind sets with durable paper cover sheets in a standardized format; include suitable titles, dates, and other identification on the cover of each set. Submit final single copy for Owner approval.

B. Private Property Release(s):

1. If the Contractor secured permission to utilize private property for staging materials and equipment, a release of liens and claims from each impacted private property owner shall be a condition precedent to Final Completion. Each release shall include certification from the impacted property owners that they are fully satisfied with the restoration of their property.

C. Service Records: Contractor shall deliver service records maintained on each item of equipment, prior to Partial Utilization.

1.13 CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide to the Owner, color digital photographic records of the Site and of the Work in accordance with the requirements of this section.

B. The Contractor shall submit photographic records, which consist of the following:

1. Photograph logs consisting of all photographs taken shall be submitted. The logs shall contain the following information:

a. Date photograph was taken.

b. Location photograph was taken and a short description of the photograph subject.

2. A compact disc containing color digital photograph files and photograph logs shall be submitted. Photograph files shall be saved in JPEG format and shall be compatible with Microsoft Windows. Individual photograph files shall be a minimum of 16.0 megapixels, and include a date stamp indicating when the photograph was taken.

C. The following photographic records shall be submitted:

1. Preconstruction Photographs: During the survey of existing facilities, the Contractor shall take and submit to the Engineer and Owner copies of photographic records to sufficiently document the existing condition of the entire Site and adjacent properties. These photographs shall be taken following surveying and flagging of the limits of disturbance, and prior to any land disturbing activities. These photographs shall consist of a minimum of 75 digital photographs taken in such quantities and at such locations to sufficiently document the existing condition of the entire Site and adjacent properties.

2. Final Completion Photographs: As a condition precedent to achieving Final Completion, the Contractor shall submit copies of photographic records to sufficiently document the entire Site and its Final Completion state. These photographs shall consist of a minimum of 75 digital photographs taken in such quantities and at such locations to sufficiently document the entire project Site and its Final Completion state, including surface restoration and wetland plantings.

D. All such photographic records shall become the property of the Owner, and the Owner shall be permitted to reproduce such photographic records and use the same for any purpose, without limitation or claim of ownership or compensation from any party.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01320

PROGRESS SCHEDULE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. This Section describes the Progress Schedule requirements to be performed by Contractor.

B. Engineer's acceptance of the Progress Schedule, and comments or opinions concerning the various scheduling documents and reports shall not control Contractor's independent judgment concerning means, methods, techniques, sequences and procedures of construction Contractor employs. Contractor is solely responsible for completing the work within the Contract Time.

C. Payment for progress or mobilization will not be paid to Contractor until the Progress Schedule has been accepted by the Owner.

D. All Activities of Contractor shall be scheduled and monitored by use of a Critical Path Method (CPM) Progress Schedule.

E. In the preparation of the Progress Schedule, Contractor shall take into consideration submittal requirements and approval time, delivery times for equipment and materials, Subcontractor's work, availability and abilities of workman, weather conditions, any restrictions in operations at the Site, and all other factors that may affect completion of the Work within the Contract Times.

F. The Contractor shall develop, revise and provide all information and input required for the Progress Schedule for the performance of the Work in accordance with the requirements of the Contract Documents in general and, in particular, this section. The Owner is the sole judge of the Progress Schedule compliance with Contract Documents.

G. The Progress Schedule shall be prepared by Contractor using Primavera Project Planner software or equal as approved by the Owner and Engineer's, conforming to the requirements herein.

H. The following terms used in this Section shall have the intent and meaning as follows:

1. Activity: An element of the Work, which has the following specific characteristics; consumes time, consumes resources, has a definable start and finish, is assignable and is measurable.

2. Constraint: An imposed date on the Progress Schedule or an imposed tie between Activities.

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3. Contract Float: The number of days between Contractor 's anticipated date for early completion of the Work and the Contract Times.

4. CPM Progress Schedule: Computerized Progress Schedule in CPM format, which accounts for the entire Work, defines the interrelationships between elements of the Work, reflects the Work remaining and the sequence with which the Work has been completed and the durations thereof.

5. Critical Path: The continuous chain of Activities with the longest duration.

6. Early Start: The earliest possible time an Activity can start according to the relationships assigned.

7. Early Finish: The earliest time an Activity can finish and not prolong the Project.

8. Late Finish: The latest time an Activity can finish and not prolong the Project.

9. Late Start: The latest time an Activity can start and not prolong the Project.

10. Float: The amount of time difference between the calculated duration of the Activity chain and the Critical Path.

11. Total Float: The number of time units that an Activity (or chain of Activities) can be delayed without affecting the Contract Times.

12. Network Diagram: A timescale logic diagram depicting the durations and relationships of the Project Activities.

13. Work Areas, Area or System: A logical breakdown of the Project elements or a group of Activities which, when they are collectively assembled are readily identifiable on the Project (e.g., yard piping, a structure, a process, etc.).

1.02 USE OF FLOAT

A. Total Float and Contract Float belong to the Project and may be used by the OWNER, Engineer's, their consultants, or Contractor to accommodate changes in the Work, however originated, or to mitigate the effect of events, which may delay performance or completion. Changes or delays that influence Activities with float and that do not extend the Critical Path will not be justification for an extension of Contract Times.

1.03 LOGIC DIAGRAM(S)

A. Prepare and submit logic diagrams. Group the logic diagrams by Area and show the order and interdependence of Activities and the sequence and quantities in which the Work is to be accomplished.

B. The Critical Path shall be distinguished from other paths on the network.

C. In addition to construction, network Activities shall include the submittal and approval of samples of materials, Shop Drawings, and fabrication of special materials.

D. All activities of the Engineer's or Owner that affect progress and special dates required by the Contract Documents shall be shown.

1.04 NARRATIVE REPORT

A. Prepare and include with the preliminary Progress Schedule submittal (and each subsequent Progress Schedule submittal), a narrative report describing the requirements and objectives of the Contract Documents and Contractor's plan and schedule for achieving those requirements and objectives. The narrative shall describe the methods of operation, the resources to be employed, time frames for the construction of each of the major systems on the Project, and time frames for accomplishment of the specified milestones and Project completion.

1.05 PROGRESS SCHEDULE SUBMITTAL

A. Submit Progress Schedule in accordance with Section 01300 Submittals.

1. The Contractor shall submit three (3) copies of the Progress Schedule in paper copies and one electronic copy in pdf format and one electronic copy in native file format. Paper schedule submittals shall be computer generated, in a time scaled format, on 30-inch by 42-inch standard size sheets. With the Owner's permission, the Contractor may submit its diagram or chart on 11" x 17" paper. The font size used in all Schedule Submittals shall be no less than 10 point.

2. Schedule Submittals shall be organized by grouping activities related to tasks or specific areas of the Project together for ease of understanding and simplification.

B. Approval of a Schedule Submittal by the Owner or Engineer is advisory only and shall not relieve the Contractor of responsibility for accomplishing the Work within the Contract Time. The Contractor is solely responsible for scheduling the Work, and any failure by the Contractor to include any element of Work required for performance of the Contract shall not excuse the Contractor from completing all Work within the Contract Time. Acceptance by the Owner or Engineer of the Contractor's Schedule Submittal shall not relieve the Contractor of any of its responsibilities whatsoever for the accuracy or feasibility of the Schedule Submittal, or of the Contractor's ability to meet Substantial Completion and Final Completion requirements of the Contract, and such acceptance also creates neither a warranty, expressed or implied, nor an acknowledgement or admission of the reasonableness of the activities, logic, durations, manpower, or cost loading of the Contractor's Schedule Submittal. The Owner hereby disclaims any obligation or liability by reason of approval by its agent, the Engineer, of the Schedule Submittal.

C. No later than 30 calendar days after the Notice to Proceed, Contractor shall submit to the Engineer the Progress Schedule. Lack of progress in the development of the

Progress Schedule shall be cause for suspension of all progress payment. The Progress Schedule will be reviewed by the Engineer within 30 calendar days of receipt or request for adjustment Any adjustments required after this period shall be made and resubmitted by Contractor within 15 calendar days.

D. If, in the preparation of the Progress Schedule, Contractor reflects a completion date or milestone date different than that specified in the Contract Documents, this in no way voids the dates set therein. The dates as specified in the Contract Documents govern. Where the Progress Schedule reflects a completion date or milestone date earlier than specified, the Engineer may accept such Progress Schedule with Contractor specifically understanding that no claim for additional Contract Times or Contract Price compensation shall be brought against the Owner as the result of failure to complete the Work by the earlier date shown on the Progress Schedule.

1.06 UPDATING THE PROGRESS SCHEDULE

A. Updates:

1. The Schedule Update shall be prepared and submitted on a monthly basis throughout the entire Contract Time and until Project Final Completion. The Contractor shall submit its Schedule Update with its Application for Payment. The Owner and Engineer may elect to meet with the Contractor to review the Schedule Update and Application for Payment. The data date of each Schedule Update shall be the last day of the month, and shall include Schedule Revisions accepted by Owner during the preceding month.

2. In case of disagreements at the Progress schedule Update meeting concerning actual progress to date, the Owner's determination shall govern.

3. Upon completion of the Progress schedule Update meeting, the Contractor will prepare a Schedule Update to reflect actual progress as of the data date and any agreed to revisions to the Progress schedule.

4. Within 5 working days after receiving the Owner comments on the Schedule Update, the Contractor shall revise its Schedule Update as requested by Owner and submit to the Owner the final Schedule Update, which shall document the Work performed during the month.

5. The Schedule Update shall be an integral part and basic element of the estimate upon which partial payments will be made. Submission by the Contractor, to the satisfaction of the Owner, of the Contractor’s Schedule Submittals, Progress schedule updates, logic revision requests, narrative report and complete information as specified in this section, shall be a condition precedent to any obligation of the Owner to consider any Application for Payment.

6. Contractor ’s Progress Schedule update shall include a narrative report which shall include a description of the current progress and status of each Area of the Project, a description of the progress for the period, a description of the Critical

Path, a discussion of current or potential delays, Change Orders (pending or approved), or other problems.

7. The update to the Progress Schedule shall be based on retained logic, progress override logic is not allowed.

1.07 TIME IMPACT ANALYSIS FOR CHANGE ORDERS, DELAYS AND TIME EXTENSIONS

A. Change Orders, Delays, and Time Extensions:

1. When a Change Order is proposed by the Engineer or Contractor, or delays are experienced, Contractor shall submit a Time Impact Analysis illustrating the influence of each Change Order or delay on any specified intermediate Milestone date(s) or Contract completion date. Each Time Impact Analysis shall include a sketch (fragnet) demonstrating how Contractor proposes to incorporate the change(s) or delay(s) into the Progress Schedule. The fragnet shall include all logic, cost and resource changes and additions required as a result of said Change Order or delay.

2. This fragnet shall show all CPM logic revisions for the Work in question and its relationship to other Activities in the network plan. Additionally, the analysis shall demonstrate the time impact, based on the date the change was given to Contractor, the status of construction at that point in time, and the Activity duration of all affected Activities. The Activity duration used in this analysis shall be those included in the latest update of the Progress Schedule, closest to the time of the delay as adjusted by mutual agreement, in writing.

B. Submittal:

1. Each Time Impact Analysis shall be submitted within 15 calendar days after a delay occurs or a notice of change or proposed Change Order is given to Contractor. In cases where Contractor does not submit a Time Impact Analysis for a specific change or delay within the specified period of time, it shall be mutually agreed that no time extension is required.

C. Evaluation:

1. Final evaluation of each Time Impact Analysis by the Engineer will be made within 15 calendar days after receipt, unless subsequent meetings and negotiations are necessary. Adjustments in the Contract Times for performance will be made only by written Change Order. Upon acceptance by the Owner, fragnets illustrating the influence of changes and delays shall be incorporated into the current Progress Schedule by Contractor during the first update after agreement is reached.

1.08 RECOVERY SCHEDULE

A. In the event that an updated Progress Schedule indicates that the Project, or a Milestone requirement, falls 10 or more work days behind schedule and there is no excusable delay or change to support a time extension, Contractor shall prepare and submit a Recovery Schedule for acceptance by the Engineer. Contractor shall revise logic or durations to cause the mathematical analysis to show the Project on schedule. The Recovery Schedule shall be submitted 5 calendar days after the updated Progress Schedule is submitted.

B. Contractor shall provide additional manpower, equipment, or materials or shall work additional shifts, or expedite procurement to complete Activities within the specified Milestones or Contract Times, at no additional cost to the Owner. Upon acceptance of the Recovery Schedule by the Engineer, Contractor shall incorporate it into the current Progress Schedule.

C. Lack of Action:

1. Contractor's refusal, failure, or neglect to take appropriate recovery action or to submit a written Recovery Schedule shall constitute reasonable evidence that Contractor is not prosecuting the Work, or separable part, with the diligence that will ensure its completion within the applicable Contract Times. Such lack of action shall constitute sufficient basis for the Owner to exercise remedies available under the Contract Documents.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01400

QUALITY CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Testing Laboratory Services

1. Laboratory testing and checking required by the Specifications, including the cost of transporting all samples and test specimens, shall be provided and paid for by the Owner unless otherwise indicated in the Specifications.

2. Materials to be tested include but are not necessarily limited to the following: cement, concrete aggregate, concrete, bituminous paving materials, structural and reinforcing steel, waterproofing, select backfill, crushed stone or gravel and sand.

3. Tests required by the Owner shall not relieve the Contractor from the responsibility of supplying test results and certificates from manufacturers or suppliers to demonstrate conformance with the Specifications.

4. Procedure

a. The Contractor shall plan and conduct his operations to permit taking of field samples and test specimens, as required, and to allow adequate time for laboratory tests.

b. The collection, field preparation and storage of field samples and test specimens shall be as directed by the Engineer with the cooperation of the Contractor.

5. Significance of Tests

a. Test results shall be binding on both the Contractor and the Owner and shall be considered irrefutable evidence of compliance or noncompliance with the Specification requirements, unless supplementary testing shall prove, to the satisfaction of the Owner, that the initial samples were not representative of actual conditions.

6. Supplementary and Other Testing

a. Nothing shall restrict the Contractor from conducting tests he may require. Should the Contractor at any time request the Owner to consider such test results, the test reports shall be certified by an independent

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testing laboratory acceptable to the Owner. Testing of this nature shall be conducted at the Contractor's expense.

1.02 IMPERFECT WORK, EQUIPMENT, OR MATERIALS

A. Any defective or imperfect work, equipment, or materials furnished by the Contractor which is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be removed immediately even though it may have been overlooked by the Engineer and estimated for payment. Any equipment or materials condemned or rejected by the Engineer shall be tagged as such and shall be immediately removed from the site. Satisfactory work or materials shall be substituted for that rejected.

B. The Engineer may order tests of imperfect or damaged work, equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor; and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the work, equipment, or material was not impaired, consistent with the final general appearance of same, the work, equipment, or materials may be deemed acceptable by the Owner at Owner's sole discretion. If the results of such tests reveal that the required functional capability of the questionable work, equipment, or materials has been impaired, then such work, equipment, or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect work, equipment, or material in lieu of performing the tests.

1.03 INSPECTION AND TESTS

A. The Contractor shall allow the Engineer ample time and opportunity for testing materials and equipment to be used in the work. He shall advise the Engineer promptly upon placing orders for material and equipment so that arrangements may be made, if desired, for inspection before shipment from the place of manufacture. The Contractor shall at all times furnish the Engineer and his representatives, facilities including labor, and allow proper time for inspecting and testing materials, equipment, and workmanship. The Contractor must anticipate possible delays that may be caused in the execution of his work due to the necessity of materials and equipment being inspected and accepted for use. The Contractor shall furnish, at his own expense, all samples of materials required by the Engineer for testing, and shall make his own arrangements for providing water, electric power, or fuel for the various inspections and tests of structures and equipment.

B. The Contractor shall furnish the services of representatives of the manufacturers of certain equipment, as prescribed in other Sections of the Specifications. The Contractor shall also place his orders for such equipment on the basis that, after the equipment has been tested prior to final acceptance of the work, the manufacturer will furnish the Owner with certified statements that the equipment has been installed properly and is ready to be placed in functional operation. Tests and analyses required of equipment shall be paid for by the Contractor, unless specified otherwise in the Section which covers a particular piece of equipment.

C. Where other tests or analyses are specifically required in other Sections of these Specifications, the cost thereof shall be borne by the party (Owner or Contractor) so designated in such Sections. The Owner will bear the cost of all tests, inspections, or investigations undertaken by the order of the Engineer for the purpose of determining conformance with the Contract Documents if such tests, inspection, or investigations are not specifically required by the Contract Documents, and if conformance is ascertained thereby. Whenever nonconformance is determined by the Engineer as a result of such tests, inspections, or investigations, the Contractor shall bear the full cost thereof or shall reimburse the Owner for said cost. In this connection, the cost of any additional tests and investigations, which are ordered by the Engineer to ascertain subsequent conformance with the Contract Documents, shall be borne by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01510

TEMPORARY UTILITIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Contractor shall provide temporary light and power, heating, water service and sanitary facilities for his operations. The temporary services shall be provided for use throughout the construction period.

B. Contractor shall coordinate and install all temporary services in accordance with the requirements of the utility companies having jurisdiction and as required by applicable codes and regulations.

C. At the completion of the work, or when the temporary services are no longer required, the facilities shall be restored to their original conditions.

D. All costs in connection with the temporary services including, but not limited to, installation, utility company service charges, maintenance, relocation and removal shall be borne by the Contractor at no additional cost to the Owner.

F. Temporary Light and Power

1. Contractor shall provide temporary light and power as required for his activities.

G. Temporary Heating

1. The General Contractor shall provide temporary heating, ventilation coverings and enclosures necessary to properly protect all work and materials against damage by dampness and cold, to dry out the work and to facilitate work in all structures.

H. Temporary Sanitary Service

1. Sanitary conveniences, in sufficient numbers, for the use of all persons employed on the work and properly screened from public observation, shall be provided and maintained at suitable locations by the Contractor, all as prescribed by State Labor Regulations and local ordinances. The contents of same shall be removed and disposed of in a manner consistent with local and state regulations, as the occasion requires.

I. Temporary Water

1. Contractor shall supply potable water for his employees either by portable containers or drinking fountains.

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PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01520

MAINTENANCE OF UTILITY OPERATIONS DURING CONSTRUCTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The existing wastewater pump stations shall be maintained in continuous operation during the entire construction period as hereinafter specified. The intent of this section is to outline the minimum requirements necessary to allow the Owner to continuously operate and maintain the pump stations in order to remain in compliance with all permit and practical requirements.

B. Work under each Contract shall be scheduled and conducted so as not to impede wastewater pumping or cause odor or other nuisance except as explicitly permitted hereinafter. In performing the work shown and specified, the Contractor shall plan and schedule his work to meet the collection system operating requirements, and the constraints and construction requirements as outlined in this Section. No discharge of raw wastewater shall be allowed. The Contractor shall pay all civil penalties, costs, assessments, etc., associated with any discharge of raw wastewater associated with the Contractor's work.

C. The Contractor shall be responsible for ensuring that permanent or temporary power is available for all existing, proposed, and temporary facilities that are required to be on line at any given time.

D. The Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without cost to the Owner and provided that all requirements of these Specifications are fulfilled. The Contractor shall submit any such plan for providing additional temporary facilities to eliminate a constraint to the Owner for review. Such plans must be approved by the Engineer and Owner prior to the Contractor proceeding. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section shall be consecutive calendar days.

1.02 GENERAL CONSTRAINTS

A. The Contractor shall schedule the Work so that the pump stations are maintained in continuous operation. All short-term system or partial systems shutdowns and diversions and long term shutdowns shall be approved by the Owner. Long-term process shutdowns and diversions shall conform to the requirements hereinafter specified and shall be minimized by the Contractor as much as possible. If in the judgement of the Owner a requested shutdown is not required for the Contractor to perform the Work, the Contractor shall utilize approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the Owner. Shutdowns shall not begin until all required materials are on hand and ready for installation and Owner granted approval for the shutdown. Each

shutdown period shall commence at a time approved by the Owner, and the Contractor shall proceed with the Work continuously, start to finish, until the Work is completed and normal plant operation is restored. If the Contractor completes all required Work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service.

B. The Contractor shall schedule short-term and long-term shutdowns in advance and shall present all desired shutdowns in the 30-day schedules at the progress meetings (see Section 01200). The Contractor shall notify the Owner in writing of the scheduled shut down seventy two (72) hours prior to start of the shutdown. Shutdowns shall be fully coordinated with the Owner at least 48 hours before the scheduled shutdown. Owner personnel shall operate Owner's facilities involved in the short-term and long-term shutdowns and diversions.

C. Owner reserves the right to withdraw approval for a shutdown and the right to reschedule a shutdown at any time based on the collection system conditions and/or anticipated collection system conditions.

C. Short term shutdowns in pump station will be allowed for tie-ins to existing facilities, etc. All such shutdowns shall be scheduled for low-flow periods and shall be limited to less than two (2) hours depending on incoming flow rate and storage volume in the collection and treatment system. Any shutdown of two (2) hours or longer duration shall be defined as a long-term shutdown. The Contractor shall provide appropriate diversion facilities to be approved by the Owner, and at no additional cost to the Owner, for all shutdowns. The Contractor may be allowed additional time for short-term interruptions if he can demonstrate to the Owner and Engineer that the collection system will not surcharge or overflow during the requested shutdown period. Duration of short-term interruptions allowed will depend on incoming wastewater flow rate and prevention of any discharge of raw wastewater from the collection system. The schedule and duration of short-term shutdowns shall be at the discretion of the Owner.

D. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the Contractor's work limits to maintain continuous and dependable pump station operation shall be furnished by the Contractor at the direction of the Engineer at no extra cost to the Owner.

E. The Owner shall have the authority to order Work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the pump stations.

F. If the Contractor impairs performance or operation of the pump stations as a result of not complying with specified provisions for maintaining pump station operations, then the contractor shall immediately make all repairs or replacements and do all work necessary to restore the pump station to operation to the satisfaction of the Engineer. Such work shall progress continuously to completion on a 24-hours per day, seven work days per week basis.

1.03 GENERAL OPERATING REQUIREMENTS, CONSTRAINTS, AND CONSTRUCTION REQUIREMENTS

A. Access to Plant Site, Roadways, and Parking Areas

1. An unobstructed traffic route through the main access routes shall be maintained at all times for the Owner's operations personnel and maintenance equipment. The Contractor is responsible for providing parking area for all construction activities at no additional cost to the Owner. The General Contractor shall be responsible for providing access to and for preparing and maintaining/ parking areas.

2. Vehicular access to the existing pump stations for Owner personnel shall be maintained at all times by the Contractor.

3. The Contractor shall provide temporary measures to protect the existing pavement by filling over with earthen material or supplying other measures acceptable to the Engineer, and he shall repair any damage to existing paved surfaces that occurs during the construction period. Any areas disturbed along the shoulders of the access road or parking lots and elsewhere inside and outside of the pump station sites shall be repaired, graded, seeded, etc. as necessary to match pre-existing conditions.

4. The Contractor shall not undertake the restoration/construction of the roadways (paved, gravel, or asphalt overlay) shown on the Contract Drawings, until all other work on site improvements has been completed.

5. It shall be the responsibility of the Contractor to obtain any permits required from the Virginia Department of Transportation and pay all associated fees.

B. Personnel Access

1. Owner personnel shall have access to all areas which remain in operation throughout the construction period. The Contractor shall locate stored material, dispose of construction debris and trash, provide temporary pathways, provide temporary lighting, and other such work as directed by the Engineer to maintain personnel access to areas in operation. Access and adequate parking areas for plant personnel must be maintained throughout construction.

C. Power, Light and Communications Systems (General)

1. Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas which remain in operation. Individual units may be disconnected as required for replacement, but service shall be available at all times. Shutdown of electrical facilities shall be limited to not more than two (2) hours. The Owner may allow longer outages under conditions determined by the Owner by making use a portable engine-generator at the pump station. All costs associated with operation of the engine-generators shall be paid by the Contractor. The Electrical Contractor shall coordinate shutdowns required with the General Contractor to minimize the total number of shutdowns required to complete construction.

D. Draining Pipes and Conduits (General)

1. The contents of all pipes and conduits to be abandoned, removed, replaced or relocated (or dewatered for a specific purpose) shall be transferred to a suitable facility in a manner approved by the Owner through hoses or piping, or by using pumps if hydraulic conditions so require them. The Contractor shall provide the pumps, piping and hoses at no additional cost to the Owner. No uncontrolled spillage of a pipe or conduit shall be permitted. Any spillage, other than potable water, shall be immediately washed down and flushed into the appropriate receptacles. Any spillage, other than potable water shall be immediately reported to the proper regulating bodies, Owner and Engineer.

E. A temporary bypass pumping plan shall be submitted to the Owner and Engineer for approval. The Contractor shall minimize the duration of temporary bypass pumping. Bypass pumping operation is acceptable during power feed modifications, testing of the new facilities, utility connections, and as approved by the Owner.

1. Provide all materials, labor and equipment for the design, installation, operation, maintenance and removal of a temporary pumping system with standby pumping capacity and flow monitoring. Included, but not limited to, pumps and standby pumps, piping, valves, air release valves, plugs, fuel, anchors, supports, blocking, controls, notifications/alarms and ancillary items required for a complete system sized to adequately and safely convey the incoming flow without surcharging downstream sewers.. The pumps shall be provided with sound attenuation to maintain noise levels below 65 dBa measured at a distance of five (5) feet from the pumps.

2. The submittal shall include pumping system layout drawings; hydraulic design calculations; list of equipment and materials; provisions for monitoring the performance of the system, including emergency response; schedules showing manpower, planned duration of pumping operations and routine maintenance; manufacturer's cut sheets for pumps, pipes and hoses, valves, couplings and sewer plugs. The layout drawings shall include: staging areas for pumps; plan views and sections of each pump with field verified elevations; piping layout including size, length and material for suction and discharge; location and types of fittings, valves, anchors and other appurtenances; sewer plugging locations, method and types of plugs; temporary pipe supports and anchoring. Calculations showing pump sizes and capacities, hydraulic calculations of static head, friction losses, and flow velocity; system curve and pump curves showing pump operating range; fuel consumption and storage times and piping thrust and restraint design. Shop drawings showing the control and alarm systems; method of noise control and power requirements for each pump. Layout drawings showing pump control and alarm levels. Schedules for installation of and maintenance of the pumping system. The temporary pumping plan shall be prepared and signed by a Professional Engineer licensed in the Commonwealth of Virginia.

3. Construction of the temporary pumping system shall not begin until all provisions and requirements have been reviewed and approved by the Engineer.

4. Contractor is responsible for the entire pump-around operation. Any fines and/or expenses resulting from inadequate or failed pump-around operations, including

those associated with sanitary sewer overflows, shall be borne entirely by the Contractor.

5. Provide at least one qualified and competent employee to operate and maintain all temporary pumping operations. The presence of the competent operator shall be mandatory within 30 minutes or less from the time an alarm is activated and/or Contractor is acknowledged or aware of the situation. Contractor shall immediately notify the Owner after acknowledgement or becoming aware of the alarm situation.

1.04 SUGGESTED SEQUENCES OF CONSTRUCTION

A. The following describes the general suggested sequence of construction of the Work. The sequence does not purport to include all Work necessary and it may be modified to suit existing conditions encountered. It shall be used as a guide to prepare the construction schedule and the shutdown schedule. The Contractor is solely responsible for scheduling the project in conjunction with the anticipated construction sequence and the absolute requirement to maintain sewage flow in continuous operation.

B. Pennsylvania Avenue Pump Station

1. Install erosion and sediment control measures in accordance with site plan.

2. Perform a facility survey of existing site, structures and pipeline locations and inverts.

3. Perform selective demolition of site fencing and

4. Install new bypass connection on the existing force main.

5. Install new pump station facilities

   a. Relocate electrical underground and overhead lines, coordinate with provider Shenandoah Valley Electric Cooperative. Upgrade electrical service. Installation shall be in accordance with Section 16000.

   b. Install new manhole, wet well and vault.

   c. Construct electrical building and generator pad.

   d. Install all interior mechanical, electrical, instrumentation, and HVAC equipment and associated piping and conduits and wire.

   e. Install all underground utilities.

6. Make connection to the existing utilities.

7. Coordinate with Owner and M.C. Dean for connection of communication systems.

8. Test all new piping and facilities in accordance with Section 01650, Start-Up and Testing.

9. Operate new pump station.

10. Demolish existing pump station.

11. Perform site work.

12. Obtain Substantial Completion of pump station.

C. Conway Pump Station

1. Install erosion and sediment control measures in accordance with site plan.

2. Perform a facility survey of existing site, structures and pipeline locations and inverts.

3. Perform selective demolition of site fencing and

4. Install new bypass connection on the existing force main.

5. Install new pump station facilities

   a. Relocate electrical underground and overhead lines, coordinate with provider Shenandoah Valley Electric Cooperative. Upgrade electrical service. Installation shall be in accordance with Section 16000.

   b. Install new manhole, wet well and vault.

   c. Construct electrical building and generator pad.

   d. Install all interior mechanical, electrical, instrumentation, and HVAC equipment and associated piping and conduits and wire.

   e. Install all underground utilities.

6. Make connection to the existing utilities.

7. Coordinate with Owner and M.C. Dean for connection of communication systems.

8. Test all new piping and facilities in accordance with Section 01650, Start-Up and Testing.

9. Operate new pump station.

10. Demolish existing pump station.

11. Perform site work.

12. Obtain Substantial Completion of pump station.

1.05 SPECIFIC OPERATIONAL CONSTRAINTS

A. The Contractor shall schedule the work for the following based on the constraints given in such a manner as to maintain each pump station in continuous operation.

B. Pennsylvania Avenue Pump Station:

1. If a pump and haul is required for the Pennsylvania Avenue WWPS the flow shall be picked up from City MH 114-1 and hauled to City MH 133-10.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION –

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SECTION 01525

EMERGENCY BYPASS PUMPING SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Provisions for furnishing, installation, and operation of an emergency bypass pumping system, to convey wastewater from the Pennsylvania Ave or Conway Pump Stations in the event of an emergency due to no fault of the Contractor during construction.

1.02 THE REQUIREMENTS

A. It is the intent of this section that the Contractor arrange to have an emergency bypass pumping system on standby during active construction and available for use within 4 hours of an emergency. The cost of the standby provision shall be included in Bid Item 1.

B. Costs associated with installation, operation and removal of the emergency bypass pumping system shall be paid for under Bid Items 5 and 6.

C. Provide all materials, labor and equipment for the installation, operation, maintenance and removal of an emergency bypass pumping system. Included, but not limited to, pumps, piping, valves, air release valves, plugs, fuel, anchors, supports, blocking, controls, notifications/alarms and ancillary items required for a complete system sized to adequately and safely convey the incoming flow without surcharging downstream sewers. The pumps may be electrically or diesel driven.

D. The emergency bypass pumping system shall remain operational until approval for removal is obtained from the Owner.

E. Emergency bypass pumping system shall meet the City of Winchester and Frederick County noise ordinances.

1.03 SYSTEM DESCRIPTION

A. Design and Performance Requirements

1. Design conditions

a. Pennsylvania Avenue Wastewater Pump Station bypass pumping shall be a peak flow of 600 gallons per minute at 81 feet of total dynamic head and an average flow of 300 gallons per minute at 55 feet of total dynamic head. The Pennsylvania Avenue Pump Station has a 8-inch discharge force main. The suction manhole is City MH 114-1 with an influent invert of approximately 710.28 feet.

b. Conway Wastewater Pump Station bypass pumping shall be a peak flow of 800 gallons per minute at 81 feet of total dynamic head and an average flow of 400 gallons per minute at 45 feet of total dynamic head. The Conway Pump Station has a 8-inch discharge force main. The suction manholes are City MH #906 with an discharge invert of approximately 669.17 feet and City MH 155 with an discharge invert of approximately 674.82 feet.

c. Contactor shall confirm suction and discharge locations and invert elevations. Contractor is responsible for modifying design conditions based on actual locations and elevations.

2. Size system to adequately and safely convey the design flow from the existing sanitary sewers to the force main outfall structure, using the emergency bypass connection(s) on the force main(s).

3. Provide duty pump to convey the design flow and a minimum of one standby pump equivalent (at least) in size to the duty pump.

4. Have all pumps (duty and standby) piped and ready to pump at all times from the time of installation until removal. Arrange pumps and valves so that any pump can be removed and replaced (if necessary) without interrupting the conveyance of flow.

5. Convey flow in a manner that does not cause surcharging of local sewers, and that protects public and private property from damage.

6. Operate the pumping system continuously, i.e. 24 hours per day, 7 days per week, when in service.

7. Provide all pump controls and a notification/alarm system for pumping system.

8. Provide fuel and fuel storage for continuous operation specified herein.

9. Contractor is responsible for the entire emergency bypass pumping system operation. Any fines and/or expenses resulting from inadequate or failed pump-around operations, including those associated with sanitary sewer overflows, shall be borne entirely by the Contractor.

1.04 SUBMITTALS

A. Prepare a project specific temporary pumping plan and obtain the Engineer's approval at least thirty (30) days in advance of the scheduled time of the work.

1. The plan shall include, but not be limited to:

a. Pumping system layout drawings; hydraulic design calculations; list of equipment and materials; provisions for monitoring the performance of the system, including emergency response; schedules showing manpower, planned duration of pumping operations and routine maintenance;

b. Manufacturer's cut sheets for pumps, pipes and hoses, valves, couplings and sewer plugs;

c. Layout drawings showing: staging areas for pumps; plan views and sections of each pump with field verified elevations; piping layout including size, length and material for suction and discharge; location and types of fittings, valves, anchors and other appurtenances; sewer plugging locations, method and types of plugs; temporary pipe supports and anchoring.

d. Calculations showing pump sizes and capacities, hydraulic calculations of static head, friction losses, and flow velocity; system curve and pump curves showing pump operating range; fuel consumption and storage times and piping thrust and restraint design.

e. Shop drawings showing the control and alarm systems; method of noise control and power requirements for each pump.

f. Schedules for installation of and maintenance of the pumping system.

B. Quality Control Submittals

1. Experience qualifications for service provider or subcontractor

1.05 QUALITY ASSURANCE

A. Provide materials, equipment, and services from a provider or subcontractor having at least five years experience in design, production, assembly, and field service of similar temporary pumping systems.

B. Communication Requirements

1. Provide at least one qualified and competent employee (competent operator) to operate and maintain all temporary pumping operations.

2. The competent operator shall be at the jobsite or on-call at all times (24 hours per day) while the pump station is dependent on the temporary pump-around system.

3. The competent operator shall be on the jobsite whenever problems are occurring with any portion of the temporary pump-around system.

4. The presence of the competent operator shall be mandatory within 30 minutes or less from the time an alarm is activated and/or Contractor is acknowledged or aware of the situation. Contractor shall immediately notify the Owner after acknowledgement or becoming aware of the alarm situation.

C. All equipment shall arrive at the jobsite in a reliable and well-maintained condition. All pumps shall be inspected for wear prior to arriving to the job site and shall have all wearable items replaced.

1.06 EXISTING SITE CONDITIONS

A. Bypass pumping shall be located on the existing pump station site.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pumps:

1. Provide fully automatic self priming units that do not require the use of foot valves or vacuum pumps in priming the system. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of flows. Pumps shall be capable of handling solids up to 3 inches.

2. Design for continuous duty operation in air for application in a temporary pump-around system. Do not overload the motors at any point on the pump performance curve throughout the specified speed range.

3. Provide pressure gauges on the pump discharge located as close as possible to the pump volute discharge.

4. Acceptable Manufacturers

a. Godwin, Gorman Rupp, or equal.

B. Controls:

1. Provide each pump with a HAND-OFF-AUTOMATIC selector switch. During normal operation, the duty pump shall automatically start and stop based on level controls.

C. Piping:

1. Provide screening as necessary on the suction piping and use quick connect couplings for pump switch-out as needed.

2. Provide discharge piping constructed of rigid pipe or hose. Provide isolation, check valves, and air and vacuum relief valves as needed.

2.02 ACCESSORIES

A. Provide sound attenuation enclosure(s), temporary structure(s), sound insulation, and other means, as required, to meet maximum sound level requirements of 50 dBA at the property line.

2.03 OFF SITE NOTIFICATION SYSTEMS

A. Provide all required Work to Notify off site personnel of problems with the emergency pumping system. The system shall provide notification to the Owner and Contractor. Maintain a current list of personnel (name, address, telephone number) at the site at all times. Provide local alarm beacon to indicate alarm conditions.

2.04 POWER

A. Provide all power required for complete operation of the pump-around system (including controls, lights, etc.).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify all dimensions and conditions relative to the performance of the temporary pump-around system.

3.02 PREPARATION

A. Clean all pipe and manholes if they are found to contain grit, sludge or blockage that will hinder the operation or maintenance of the pumping system. Protect all existing structures and pipes from damage.

B. If used, sound attention measures/structures shall be installed prior to the start-up of the pumping system.

3.03 INSTALLATION

A. Install system in accordance with approved submittals and the manufacturer's installation instructions. Locate all piping, pumping and other equipment so as to provide the least amount of disruption to normal activities.

B. The Contractor shall be responsible to make any modifications to the existing sanitary manholes, etc. as necessary to accommodate the temporary pumping system. Contractor shall restore any modified or affected structures to a condition equal to the original or better than what existed prior to the construction.

C. All piping, hoses and connections shall be secured and durable. All pipe joints shall be free of leakage.

D. Plugging or blocking of sewage flows shall incorporate a primary and secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance or work, remove it in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

E. Locate the pumps and pipelines off of streets and sidewalks and shoulders of the roads.

F. Secure, any temporary pump-around facilities located outside of the site fence line with a temporary chain link fence, gate and lock.

3.04 MAINTENANCE

A. Inspect emergency bypass pumping system regularly to ensure that the system is working correctly. Inspect and ensure proper operating condition of the pumping system at least at 7 A.M. and 7 P.M., seven (7) days a week. However, Engineer has the right to increase the frequency of inspection as required.

B. Have available, at all times, sufficient repair parts, tools and equipment, on-site to assure rapid emergency troubleshooting and repair of any pump or equipment.

C. Maintain alarm and notification system throughout the duration of the emergency bypass pumping operations.

3.05 CLEANING AND RESTORATION

A. Following the completion of the emergency bypass pumping operations:

1. Restore disturbed areas to the original or better conditions that existed prior to the construction.

2. Flush with clean water, all sanitary sewers surcharged during the temporary pump-around operations to remove any solids deposited in the sewers during surcharging.

- END OF SECTION -

SECTION 01530

PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Contractor shall be responsible for the preservation and protection of property adjacent to the work site against damage or injury as a result of his operations under this Contract. Any damage or injury occurring on account of any act, omission or neglect on the part of the Contractor shall be restored in a proper and satisfactory manner or replaced by and at the expense of the Contractor to an equal or superior condition than previously existed.

B. Contractor shall comply promptly with such safety regulations as may be prescribed by the Owner or the local authorities having jurisdiction and shall, when so directed, properly correct any unsafe conditions created by, or unsafe practices on the part of, his employees. In the event of the Contractor's failure to comply, the Owner may take the necessary measures to correct the conditions or practices complained of, and all costs thereof will be deducted from any monies due the Contractor. Failure of the Engineer to direct the correction of unsafe conditions or practices shall not relieve the Contractor of his responsibility hereunder.

C. In the event of any claims for damage or alleged damage to property as a result of work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defense against such claims. Prior to commencement of work in the vicinity of property adjacent to the work site, the Contractor, at his own expense, shall take such surveys as may be necessary to establish the existing condition of the property. Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained.

1.02 PROTECTION OF WORK AND MATERIAL

A. During the progress of the work and up to the date of final payment, the Contractor shall be solely responsible for the care and protection of all work and materials covered by the Contract.

B. Contractor shall employ such means and methods necessary to adequately protect public and private property and property of the Owner against damage. In the event of damage to such property, Contractor shall immediately restore the property to a condition equal to its original condition and to the satisfaction of the Owner and the owner of said property and bear all costs thereof.

C. Contractor shall protect stored materials and other items located adjacent to the Work.

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D. Fire Prevention: Contractor shall perform all Work in a fire safe manner; furnish and maintain on the Site adequate firefighting equipment; and comply with applicable federal, local, and state fire prevention regulations. Where these regulations do not apply, Contractor shall follow applicable parts of the National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241).

1.03 BARRICADES, WARNING SIGNS AND LIGHTS

A. The General Contractor shall provide, erect and maintain as necessary, strong and suitable barricades, danger signs and warning lights along all roads, walkways and areas accessible to the public, as required by the authority having jurisdiction, to ensure safety to the public. All barricades and obstructions along public roads shall be illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise.

B. Contractor shall provide and maintain such other warning signs and barricades in areas of and around their respective work as may be required for the safety of all those employed in the work, the Owner's operating personnel, or those visiting the site.

C. Contractor shall provide additional facilities at the request of the Owner if in the Owner's judgement the Contractor provided means of protecting property and public are not sufficient.

1.04 EXISTING UTILITIES AND STRUCTURES

A. The term existing utilities shall be deemed to refer to both publicly-owned and privately-owned utilities such as electric power and lighting, telephone, water, gas, storm drains, process lines, sanitary sewers and all appurtenant structures.

B. Where existing utilities and structures are indicated on the Drawings, it shall be understood that all of the existing utilities and structures affecting the work may not be shown and that the locations of those shown are approximate only. It shall be the responsibility of the Contractor to ascertain the actual extent and exact location of existing utilities and structures. In every instance, the Contractor shall notify the proper authority having jurisdiction and obtain all necessary directions and approvals before performing any work in the vicinity of existing utilities.

C. Prior to beginning any excavation work, the Contractor shall, through field investigations, determine any conflicts or interferences between existing utilities and new utilities to be constructed under this project. This determination shall be based on the actual locations, elevations, slopes, etc., of existing utilities as determined in the field investigations, and locations, elevation, slope, etc. of new utilities as shown on the Drawings. If an interference exists, the Contractor shall bring it to the attention of the Engineer as soon as possible. If the Engineer agrees that an interference exists, he shall modify the design as required. Additional costs to the Contractor for this change shall be processed through a Change Order as detailed elsewhere in these Contract Documents. In the event the Contractor fails to bring a potential conflict or interference to the attention of the Engineer prior to beginning excavation work, any actual conflict or

interference which does arise during the Project shall be corrected by the Contractor, as directed by the Engineer, at no additional expense to the Owner.

D. The work shall be carried out in a manner to prevent disruption of existing services and to avoid damage to the existing utilities. Temporary connections shall be provided, as required, to insure uninterruption of existing services. Any damage resulting from the work of this Contract shall be promptly repaired by the Contractor at his own expense in a manner approved by the Engineer and further subject to the requirements of any authority having jurisdiction. Where it is required by the authority having jurisdiction that they perform their own repairs or have them done by others, the Contractor shall be responsible for all costs thereof.

E. Where excavations by the Contractor require any utility lines or appurtenant structures to be temporarily supported and otherwise protected during the construction work, such support and protection shall be provided by the Contractor. All such work shall be performed in a manner satisfactory to the Engineer and the respective authority having jurisdiction over such work. In the event the Contractor fails to provide proper support or protection to any existing utility, the Engineer may, at his discretion, have the respective authority to provide such support or protection as may be necessary to insure the safety of such utility, and the costs of such measures shall be paid by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01540

DEMOLITION AND REMOVAL OF EXISTING STRUCTURES AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. This Section covers the demolition, removal, and disposal of existing buildings, structures, pavement, curbs, and sidewalk, removal and disposal of asbestos materials, and any existing equipment including electrical, plumbing, heating and ventilating equipment and piping not required for the operation of the rehabilitated facility as indicated on the Drawings and as specified hereinafter. The Contractor shall furnish all labor, materials and equipment to demolish buildings and structures and to remove fixtures, anchors, supports, piping and accessories designated to be removed on the Drawings.

B. Demolition work shall be performed in accordance with the Contract Documents and shall be coordinated with the Owner and with the Closure Plan for the Courtland Rural Village WRF Facilities.

1.02 TITLE TO EQUIPMENT AND MATERIALS

A. Contractor shall have no right or title to any of the equipment, materials or other items to be removed from the existing buildings or structures unless and until said equipment, materials and other items have been removed from the premises. The Contractor shall not sell or assign, or attempt to sell or assign any interest in the said equipment, materials or other items until the said equipment, materials or other items have been removed.

B. Contractor shall have no claim against the Owner because of the absence of such fixtures and materials.

C. The equipment and material retained by the Owner shall be moved by the Contractor from the project sites and placed by the Contractor in a location designated by the Owner. The Contractor shall provide loading, transport, and unloading in accordance with VDOT and Owner requirements. The Contractor shall coordinate equipment transport and relocation with the Owner. The following equipment and materials will be retained by the Owner:

1. All existing control panels.

1.03 CONDITION OF STRUCTURES AND EQUIPMENT

A. The Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and/or removed.

B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner so far as practicable.

C. The information regarding the existing structures and equipment shown on the Drawings

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is based on visual inspection and a walk-through survey only. Neither the Engineer nor the Owner will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

D. The Contractor is responsible for isolation provisions to accomplish Work. Where available the existing isolation provisions may be used with Owner approval, however, the Owner makes no guarantees as to their condition and suitability.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

3.01 DEMOLITION AND REMOVALS

A. The removal of selected equipment, piping, and materials from the existing facilities and structures shall, when released by the Owner and Engineer, shall be done by the Contractor and shall become the Contractor's property, unless otherwise noted, for disposition in any manner not contrary to the Contract requirements and shall be removed from the site to the Contractor's own place of disposal.

B. The Contractor, shall de-energize all panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar power equipment prior to removal. Any electric panels or equipment which are to be retained shall be relocated or isolated by the Contractor specifically, prior to the removal of the equipment specified herein.

C. The Contractor shall proceed with the removal of the equipment, piping and appurtenances in a sequence designed to maintain the facility in continuous operation as described in Section 01520, Maintenance of Utilities Operations During Construction, and shall proceed only after approval of the Engineer.

D. Any equipment piping and appurtenances removed without proper authorization, which are necessary for the operation of the existing facilities shall be replaced to the satisfaction of the Engineer at no cost to the Owner.

E. Excavation caused by demolitions shall be backfilled with fill free from rubbish and debris.

F. Existing concrete and asphaltic paving, curbs, sidewalk and miscellaneous yard structures designated on the Drawings shall be completely demolished and all debris removed from the site.

G. Where parts of existing structures are to remain in service, demolish the portions to be removed, repair damage, and leave the structure in proper condition for the intended use. Remove concrete and masonry to the lines designated by drilling, chipping, or other suitable methods. Leave the resulting surfaces reasonably true and even, with sharp

straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended. Where existing reinforcing rods are to extend into new construction, remove the concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing 1/2-inch below the surface and fill space with epoxy resin binder flush with the surface.

H. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of the adjoining and/or nearby structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims. See Section 01300, Submittals for details relating to preconstruction documentation.

3.02 PROTECTION

A. Demolition and removal work shall be performed by competent experienced workmen for the various type of demolition and removal work and shall be carried out through to completion with due regard to the safety of Owner employees, workmen on-site and the public. The work shall be performed with as little nuisance as possible.

B. The work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, all governing codes, and as hereinafter specified.

C. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. The Contractor shall give particular attention to shoring and bracing requirements so as to prevent any damage to new or existing construction.

D. The Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

E. The Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.

F. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new work is being done, connections made, materials handled or equipment moved.

G. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing buildings affected by the operations under this Section shall be protected by dust-proof partitions and other adequate means.

H. The Contractor shall provide adequate fire protection in accordance with local Fire Department requirements.

I. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.

J. The Contractor shall be responsible for any damage to the existing structures or contents by reason of the insufficiency of protection provided.

3.03 WORKMANSHIP

A. The demolition and removal work shall be performed as described in the Contract Documents. The work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration and new work in accordance with applicable Technical Sections of the Specifications and in accordance with the details shown on the Drawings. Prior to starting of work, the Contractor shall provide a detailed description of methods and equipment to be used for each operation and the sequence thereof for review by the Engineer.

B. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. Concrete bases, anchor bolts and other supports shall be removed to approximately 1-inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas. Superstructure wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified under applicable Sections of these Specifications, as shown on the Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate Sections of these Specifications, as shown on the Drawings, and as directed and approved by the Engineer.

C. Materials or items designated to remain the property of the Owner shall be as hereinafter tabulated. Such items shall be removed with care and stored at a location at the site to be designated by the Owner.

D. Where equipment is shown or specified to be removed and relocated, the Contractor shall not proceed with removal of this equipment without specific prior approval of the Engineer. Upon approval, and prior to commencing removal operations, the equipment shall be operated in the presence of representatives of the Contractor, Owner and Engineer. Such items shall be removed with care, under the supervision of the trade responsible for reinstallation and protected and stored until required. Material or items damaged during removal shall be replaced with similar new material or item. Any equipment that is removed without proper authorization and is required for facility operation shall be replaced at no cost to the Owner.

E. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.

F. Materials or items demolished and not designated to become the property of the Owner or to be reinstalled shall become the property of the Contractor and shall be removed from the property and legally disposed of.

G. The Contractor shall execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the building.

H. In general, masonry shall be demolished in small sections, and where necessary to prevent collapse of any construction, the Contractor shall install temporary shores, struts, and bracing.

I. Where alterations occur, or new and old work join, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, so as to leave the altered work in as good a condition as existed prior to the start of the work. The materials and workmanship employed in the alterations, unless otherwise shown on the Drawing or specified, shall comply with that of the various respective trades which normally perform the particular items or work.

J. The Contractor shall finish adjacent existing surfaces to new work to match the specified finish for new work. The Contractor shall clean existing surfaces of dirt, grease, loose paint, etc., before refinishing.

K. The Contractor shall cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.

L. The Contractor shall confine cutting of existing roof areas designated to remain to the limits required for the proper installation of the new work. The Contractor shall cut and remove insulation, etc., and provide temporary weather tight protection as required until new roofing and flashings are installed.

M. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the work.

3.04 MAINTENANCE

A. The Contractor shall maintain the buildings, structures and public properties free from accumulations of waste, debris and rubbish, caused by the demolition and removal operations.

B. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish, and he shall wet down dry materials to lay down and prevent blowing dust.

C. At reasonable intervals during the progress of the demolition and removal work or as directed by the Engineer, the Contractor shall clean the site and properties, and dispose of waste materials, debris and rubbish.

- END OF SECTION -

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SECTION 01550

SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Access Roads

1. The General Contractor shall construct and maintain such temporary access as required to perform the work of this Contract.

2. Access roads, where possible, shall be located over the areas of the future road system.

3. Access roads shall be located within the property or easement lines of the Owner unless the Contractor independently secures easements for his use and convenience. Contractor shall submit written documentation to the Engineer for any Contractor secured easements across privately held property. Easement agreement shall specify terms and conditions of use and provisions for site restoration. A written release from the property owner certifying that all terms of the easement agreement have been complied by the Contractor shall be furnished to the Engineer prior to final payment.

   a. Access to the Conway Pump Station site shall be coordinated with the Owner and the property owner.

4. Existing access roads used by the Contractor shall be suitably maintained by the Contractor at his expense during construction. Contractor shall not be permitted to restrict Owner access to existing facilities. Engineer may direct Contractor to perform maintenance of existing access roads when Engineer determines that such work is required to insure all weather access by the Owner.

5. The Contractor shall obtain and pay all cost associated with all permits and bonds required by the Virginia Department of Transportation for the use of State maintained roads.

B. Restoration

1. At the completion of the work, the surfaces of land used for access roads and parking areas shall be restored by Contractor to its original condition and to the satisfaction of the Owner.

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C. Traffic Regulations

1. Contractor shall obey all traffic laws and comply with all the requirements, rules and regulation the Virginia Department of Transportation and other local authorities having jurisdiction to maintain adequate warning signs, lights, barriers, etc., for the protection of traffic on public roadways.

D. Storage of Equipment and Materials

1. Contractor shall store his equipment and materials in accordance with the requirements of the General Conditions, the Supplemental Conditions, and as hereinafter specified. All equipment and materials shall be stored in accordance with manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations and rulings of the public authority having jurisdiction. Where space or strip heaters are provided within the enclosure for motors, valve operators, motor starters, panels, instruments, or other electrical equipment, the Contractor shall make connections to these heaters from an appropriate power source and operate the heaters with temperature control as necessary until the equipment is installed and being operated according to its intended use.

2. Contractor shall enforce the instructions of Owner and Engineer regarding the posting of regulatory signs for loadings on structures, fire safety, and smoking areas.

3. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

4. Contractor shall not store unnecessary materials or equipment on the job site, and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.

5. Materials shall not be placed within ten (10) feet of fire hydrants. Gutters, drainage channels and inlets shall be kept unobstructed at all times.

6. Contractor shall provide adequate temporary storage buildings/facilities, if required, to protect materials or equipment on the job site.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01560

TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General:

1. The Contractor in executing the Work shall maintain areas within the site free from environmental pollution that would be in violation of federal, state, or local Regulations.

2. Contractor shall not impair operation of existing facilities and shall plan and conduct the Work to prevent spills from the Owner's facilities. Contractor shall prevent construction material, pavement, concrete, earth, volatile wastes, corrosive wastes, and other debris from entering sewers, pump stations, or other systems.

3. Within 30 days from Notice to Proceed, Contractor shall submit a spill prevention and response plan.

4. The Contractor shall maintain two emergency spill control kits onsite as part of the specified spill prevention and response plan. Spill control kits shall contain both sheet and tubular sorbent with a minimum spill capacity of 15 gallons for each kit.

B. Water Pollution Control:

1. Contractor shall comply with Laws, rules, and Regulations of the Commonwealth of Virginia, City of Winchester, and agencies of the United States Government prohibiting the pollution of lakes, groundwater, wetlands, streams, or river waters.

2. Erosion and Sediment Control:

a. Contractor shall comply with the rules, regulations, and procedures of Commonwealth of Virginia and City of Winchester for erosion and sediment control, and these Contract Documents including the approved site plan amendment. In the case of conflict, the more stringent requirement shall apply.

b. Maintain temporary seeding and control weeds over all disturbed areas as specified. Failure of the Contractor to comply within 5 days of receipt of written notice from the Owner to do so shall be cause for the Owner to perform such Work. All costs incurred by the Owner shall be borne by the Contractor.

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3. Contractor shall maintain the Site and affected other properties free of weeds and from accumulations of waste, debris, and rubbish caused by construction operations, encountered in excavations, and removed from structures.

4. All waste materials shall become the property of the Contractor and shall be removed from the Site. No waste materials or other materials not authorized by the Owner shall be disposed of on the Owner's property.

5. Cleaning, storage and disposal shall comply with applicable antipollution laws, ordinances and regulations. Contractor shall not burn or bury rubbish or waste materials on the Site nor dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner on the ground or in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Contractor shall provide containers approved by the Engineer for collection and disposal of waste materials, debris and rubbish.

6. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. Dispose of all materials weekly or as required for pest and rodent control.

D. Air Pollution Control:

1. Contractor shall minimize air pollution likely to occur from construction operations by wetting bare soils, cleaning and roads, as necessary, requiring proper combustion emission control devices on construction vehicles and equipment, and by shutdown of motorized equipment not in use.

2. Operations of excavating, loading, transporting, and dumping excavated materials shall be conducted in a manner as to minimize dust. Dust control shall be accomplished at least daily. Owner may require wetting and cleaning more often at its sole discretion. Failure by the Contractor to comply with such requirements within 2 hours of receipt of written Notice from the Owner to do so shall be cause for the Owner to perform such work. All costs incurred by the Owner in taking over and performing such work shall be borne by the Contractor.

3. Trash/waste burning and open fires is prohibited on the Site.

E. Noise Control:

1. Contractor shall minimize noise by executing Work using appropriate construction methods and equipment; provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels; and comply with all requirements of City of Winchester and Frederick County.

2. Submit to the Engineer plans to mitigate construction noise impacts and to comply with noise limitation criteria, including methods of construction, equipment and acoustical treatment.

3. Contractor shall limit noise from construction vehicles. Parking of vehicles, including idling construction vehicles at the project site, on the adjacent properties and roads is strictly prohibited.

F. Pest and Rodent Control:

1. Contractor shall comply with local health requirements for pest and rodent control and cooperate with agencies and companies authorized to spray or provide other treatments to prevent insect outbreaks.

2. Contractor shall take appropriate measures to prevent entry of rodents into finished buildings and Contractor shall inspect for rodents during cleaning, remove debris, and treat infested areas to Owner's satisfaction.

G. Overall Site Condition: The Contractor shall maintain the Site clean and free of debris.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and Install

1. Where the words "furnish", "provide", "supply", "replace", or "install" are used, whether singularly or in combination, they shall mean to furnish and install, unless specifically stated otherwise.

2. In the interest of brevity, the explicit direction "to furnish and install" has sometimes been omitted in specifying materials and/or equipment herein. Unless specifically noted otherwise, it shall be understood that all equipment and/or materials specified or shown on the Drawings shall be furnished and installed under the Contract as designated on the Drawings.

B. Concrete Foundations for Equipment

1. Each Contractor shall provide all concrete foundations shown, specified or required for all equipment furnished under their respective Contract.

2. Anchor bolts and templates for equipment foundations shall be furnished under the respective Contracts for installation by the respective Contractor. The General Contractor shall cooperate with the respective Contractors to secure a satisfactory installation and to maintain the schedule of construction.

3. All concrete foundations for equipment shall be treated, by the respective Contractor, with an approved sealer to prevent oil from seeping into the concrete.

1.02 EQUIPMENT AND MATERIALS

A. All equipment, materials, instruments or devices incorporated in this project shall be new and unused, unless indicated otherwise in the Contract Documents. Equipment and materials to be incorporated into the work shall be delivered sufficiently in advance of their installation and use to prevent delay in the execution of the work, and they shall be delivered as nearly as feasible in the order required for executing the work.

B. The Contractor shall protect all equipment and materials from deterioration and damage, including provisions for temporary storage as needed and as specified in Section 01550, Site Access and Storage. Storage of equipment and materials shall be in locations completely protected from flooding, standing water, excessive dust, falling rock, brush fire, etc. On site storage areas shall be located sufficiently distant from all

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construction activities and the movement of construction vehicles to minimize the potential for accidental damage. Any equipment or materials of whatever kind which may have become damaged or deteriorated from any cause shall be removed and replaced by good and satisfactory items at the Contractor's expense for both labor and materials.

1.03 INSTALLATION OF EQUIPMENT

A. Equipment and materials shall be installed in accordance with the requirements of the Contract Documents.

B. Concrete foundations for equipment shall be of approved design and shall be adequate in size, suitable for the equipment erected thereon, properly reinforced, and tied into floor slabs by means of reinforcing bars or dowels. Foundation bolts of ample size and strength shall be provided and properly positioned by means of suitable templates and secured during placement of concrete. Foundations shall be built and bolts installed in accordance with the manufacturer's certified drawings.

C. Before mounting equipment on a foundation, the Contractor shall clean the top surface; if necessary, rough it with a star chisel and clean again; and clean out all foundation bolt sleeves. The Contractor shall provide a sufficient number of steel plate shims about 2-inches wide and 4-inches long, and of a varying thickness from 1/8 to 1/2-inch. A combination of these shims shall be placed next to each foundation bolt to bring the bottom of the bedplate or frame about 1/8-inch above the final setting. The equipment shall be lowered by changing the combination of shims. Using brass shim stock of various thicknesses, continue to level the equipment a little at a time and in rotation until it is at the correct elevation in both directions. When the equipment is level, tighten down on the foundation bolts a little at a time in rotation to make certain the equipment remains level and does not shift on the shims. A preliminary alignment check shall be made before grout is placed.

D. Equipment shall be set, aligned and assembled in conformance with manufacturer's drawings or instructions. Run out tolerances by dial indicator method of alignment shall be plus or minus .002-inches, unless otherwise approved by the Engineer.

E. All blocking and wedging required for the proper support and leveling of equipment during installation shall be furnished by the Contractor. All temporary supports shall be removed, except steel wedges and shims, which may be left in place with the approval of the Engineer.

F. Each piece of equipment or supporting base, bearing on concrete foundations, shall be bedded in grout. The Contractor shall provide a minimum of 1-1/2-inch thick grouting under the entire baseplate supporting each pump, motor drive unit and other equipment. Grout shall be non-shrink grout, as specified under Section 03600, Grout.

G. When motors are shipped separately from driven equipment, the motors shall be received, stored, meggered once a month, and the reports submitted to the Engineer. After driven equipment is set, the motors shall be set, mounted, shimmed, millrighted, coupled and connected complete.

1.04 CONNECTIONS TO EQUIPMENT

A. Connections to equipment shall follow manufacturer's recommendations as to size and arrangement of connections and/or as shown in detail on the Drawings or approved Shop Drawings. Piping connections shall be made to permit ready disconnection of equipment with minimum disturbance of adjoining piping and equipment.

B. The Contractor shall be responsible for bringing proper electrical service to each item of equipment requiring electrical service as shown on the Drawings or approved Shop Drawings. Electrical connections to equipment requiring electrical service shall be made by the Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

C. The Contractor shall bring and connect HVAC service to all equipment items requiring same as shown on the Drawings.

D. The Plumbing Contractor or General Contractor if no plumbing contract exists shall bring and connect plumbing service to all equipment items requiring same as shown on the Drawings.

1.05 SUBSTITUTIONS

A. Requests for substitutions of equipment or materials shall conform to the requirements of the General Conditions, Supplemental Conditions, and as hereinafter specified.

1. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature and performance data together with samples of the materials, where requested, to enable the Owner and Engineer to determine if the proposed substitution is equal.

2. Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.

3. A list of at least three (3) reasonably similar installations where the proposed substitution is equal.

4. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the Owner.

B. Where the approval of a substitution requires revision or redesign of any part of the work, including that of other Contracts, all such revision and redesign, and all new drawings and details therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to the approval of the Owner and Engineer.

C. In the event that the Engineer is required to provide additional engineering services, then the Engineer's charges for such additional services shall be charged to the

Contractor by the Owner in accordance with the requirements of the Contract Documents.

D. In all cases the Owner and Engineer shall be the judge as to whether a proposed substitution is to be approved. The Contractor shall abide by their decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the work without written approval of the Owner and Engineer.

E. Contractor shall have and make no claim for an extension of time or for damages by reason of the time taken by the Engineer in considering a substitution proposed by the Contractor or by reason of the failure of the Engineer to approve a substitution proposed by the Contractor.

F. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

1.06 TRAINING OF OWNER'S PERSONNEL

A. The Contractor shall attend coordination meetings with the Engineer and Owner. The person(s) shall coordinate with every manufacturer who is providing training, to ensure they understand their responsibility to provide effective classroom training followed by effective field training. The coordination shall also ensure that all training will include material for operating personnel plus material for maintenance personnel.

B. The Contractor shall ensure, prior to the day(s) of training that the functional tests of equipment and/or systems are complete and satisfactory, and that field conditions will be satisfactory for training. Such field conditions include but are not limited to, safe access for a group of approximately twenty people and low construction activity noise levels in the area. The person(s) shall also ensure, prior to the day(s) of training, that every manufacturer is prepared with appropriate visual aids and proper written instructional material and shall provide appropriate audiovisual equipment for classroom and/or field training.

C. Manufacturer's Representative: Where training of Owner's personnel is required in the Specifications, the Contractor shall furnish the services of a qualified manufacturer's representative to provide training to Owner's personnel for O&M of the specified equipment.

1. All training sessions shall be scheduled to accommodate Owner's personnel schedule.

a. The minimum training times stated in the equipment specifications are the total training times. For example, where one day of training is specified, the manufacturer's representative shall provide a minimum two half-day sessions. For half-day sessions, the two half-day sessions shall occur on one day: early morning start and early to mid-afternoon start. For sessions longer than 4 hours, the sessions shall occur on separate

days. Days of the week and times for training shall be determined by the Owner to accommodate treatment process and O&M work schedules.

D. Lesson Plans for Training Sessions: The Contractor shall submit to the Owner for approval lesson plans for all sessions for training of Owner's personnel, including qualifications and experience of proposed representatives of manufacturers who will be conducting training. The Submittal will be reviewed and returned to the Contractor with comments.

1. Training shall include both classroom instruction (at the Owner's site) and field instruction (at the installed equipment and/or system).

2. As a minimum, lesson plans and classroom instruction shall include:

a. Equipment/system overview, including purpose of equipment/ system; theory of operation; performance capabilities; and a description of features which make this equipment/system special and unique.

b. Description of components, including reference to visual aids (drawings, photos, samples of parts, etc.).

c. Safety Issues related to operation and related to maintenance/ repair.

d. Brief overview of manufacturer O&M manual.

e. Installation (overview).

f. Startup instructions.

g. Operation (mechanical and electrical), geared to operating personnel.

h. Shutdown instructions.

i. Procedures for short-term and long-term shutdown, including required maintenance during shutdown.

j. Maintenance (routine inspection, preventive maintenance/ lubrication, repairs, etc.), geared to maintenance personnel. Include not only the basic equipment, but also components such as motors, reducers, etc.

k. Required tools and equipment for O&M.

l. Emergency situations, capabilities and operation.

m. Troubleshooting.

n. Questions and answers.

3. As a minimum, field instruction shall include:

a. Safety review.

b. Review of unique/special features.

c. Operation of equipment/system, including demonstration of all controls and adjustments.

d. Review of all maintenance points.

e. Partial disassembly of equipment, where helpful for an understanding of the item.

f. Questions and answers.

4. Written instructional materials shall be based on the material contained in the O&M manuals and as a minimum shall contain the following:

a. Outline of the training session.

b. Safety notes.

c. Picture(s) or drawing(s) showing all parts, features, etc.

d. Parts list keyed to the drawing(s).

e. Operation outline for operating personnel.

f. Maintenance outline for maintenance personnel.

g. Space for notes.

E. The Owner reserves the right to videotape any or all manufacturer training sessions, for the Owner's use.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01650

START-UP AND FIELD TESTING

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. Start-up Services and Field Testing.

1.02 THE REQUIREMENTS

A. Prepare testing plans for each pump station including detailed test procedures, manpower schedule, and testing schedule for all facilities provided or modified as part of Work. The testing plan and testing schedule shall be submitted a minimum of 90 days prior to projected start of testing in accordance with Section 01300, Submittals. Testing plan shall include testing of piping, concrete, electrical and instrumentation testing, equipment testing, structure testing, and all other testing included in the Contract Documents. No testing shall be performed until the testing plan is accepted by the Owner.

B. Coordinate with equipment manufacturers, Owner, and Engineer to ensure presence of representatives during testing.

C. Provide the services of qualified factory trained representatives of the equipment manufacturers for all equipment furnished under this Contract, who shall provide the following services:

1. Supervise and assist in the installation of the equipment to ensure a proper installation of the equipment.

2. Check the installation of the equipment and make all necessary adjustments prior to placing the equipment in service.

3. Supervise the preliminary and final equipment and system field tests as described herein.

4. Provide manufacturer services as specified in individual specification sections in addition to the services specified herein.

5. Provide test reports, certifications, and affidavits.

6. Provide services specified in Section 01600, Manufacturer's Services.

D. Control and Information System field testing shall be in accordance with Section 17072, Field Testing.

1.03 START-UP SERVICES

A. Services During Start-Up: During the equipment start-up the Contractor shall furnish the services of factory-trained specialists of the equipment manufacturers for the equipment

to assist in the start-up and operations of the equipment.

B. Equipment testing and start-up are requisite to satisfactory completion of the contract and, therefore, shall be completed within the time specified for substantial completion.

C. The Contractor shall allow sufficient time in his construction schedule to complete equipment testing, troubleshooting, corrections, and start-up.

D. As construction of the project enters the final stages of completion, the Contractor shall, in accordance with the requirements set forth in the Contract Documents, attend to the following items:

1. Schedule equipment manufacturer's visits to site. The Contractor shall schedule and coordinate testing and start-up activities as required to ensure Owner's assistance, if required. The Owner's operations and maintenance personnel will attend testing and start-up activities.

2. Provide necessary calibrated instruments to execute performance testing.

3. Calibration of instruments and controls.

4. Perform required testing, adjusting and balancing of project equipment.

5. Schedule start-up.

6. Furnish skilled personnel during start-up and testing.

7. Perform Owner operation and maintenance training on a separate day from start-up and testing.

8. Perform testing of piping, concrete, electrical and instrumentation testing, and other testing included in the Contract Documents and required prior to equipment testing.

E. Refer to other Divisions for further requirements regarding this Section.

1.04 PRELIMINARY CHECKOUTS

A. The following operations, to be conducted in the presence of the Engineer and Owner, are a prerequisite for the Field Tests:

1. Set, align and assemble all equipment and systems in conformance with the manufacturer's drawings and instructions.

2. Check direct coupled shafts with flexible or rigid couplings for parallel and angular misalignment using dial indicators. Maximum allowable misalignment in either direction shall be 0.002-inch unless otherwise directed.

3. Check alignment and realign as necessary after all piping connections to equipment are made.

4. Check equipment for proper rotation.

5. Check motor for no-load current draw.

6. Run the equipment dry if applicable and check equipment for excessive vibration and noise.

7. Verify that equipment is free from defects.

8. Flush all bearings, gear housings, etc. in accordance with manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.

9. Perform equipment testing specified in individual equipment specifications.

B. Equipment Checkout Records

1. When the checkout operations have been completed, Contractor shall transmit to the Engineer his Equipment Checkout Record with all pertinent data from the checkouts.

2. The Equipment Checkout Record will not be valid if not initialed by the Owner or Owner's representative.

3. Field Tests will not be initiated if valid Equipment Checkout Records have not been provided for the equipment to be tested.

1.05 FIELD TESTS OF EQUIPMENT AND SYSTEMS

A. The Contractor shall provide the services of an experienced and authorized representative of the supplier of each item of equipment, who shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the Contractor shall arrange to have the supplier's representative revisit the job site as often as necessary until any and all trouble is corrected and the equipment installation and operation are satisfactory to the Engineer.

B. The Contractor shall require each supplier's representative to participate in preliminary field tests of his equipment. The supplier shall submit a written report addressed to the Owner certifying 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 tested, operated satisfactorily under full-load conditions, is ready for operation, and the Owner's operating personnel have observed the operation, maintenance and lubrication of the equipment.

C. The Contractor shall furnish all personnel, chemicals, lubricants, fuel, and all other necessary equipment, facilities, and services required for conducting tests. The Contractor shall furnish all temporary equipment, materials, and facilities that a required to enable testing of equipment over the entire operating.

D. Testing shall begin only when authorized representatives of the Engineer, Owner, and Contractor have mutually agreed that the equipment is in suitable condition for continuous operation.

E. Definition of System: A system, for purposes of testing is defined as the equipment, valves, piping, instrumentation, electrical connections, appurtenances, etc. which are so related as to form a complete pumping system, screening system, or louvers, dampers, ducts, fans, air handling units, instrumentation, etc. which are so related as to form a complete ventilation system.

F. Scope of System Testing: System testing is required to demonstrate that the equipment, interconnections, and accessories perform as specified. In addition to specific requirements called for in the specific Sections of the Contract Specifications, the following are to be considered a part of preliminary equipment and system and final equipment and system procedures:

1. Variable capacity equipment is to be operated over the full capacity range and at a minimum of 3 intermediate points for at least 30 minutes at each point.

2. Multiple equipment groupings are to be operated both singly and together up to the maximum capacity of the system.

3. Headered and cross-connected groups of units are to be operated using all connecting combinations.

4. All equipment items, including standby units are to be tested. It may be necessary to repeat system tests at maximum condition to ensure that standby units are included in system tests.

5. Each operating unit shall be run for at least continuous period of time as specified in Part 3 of this section maximum capacity after reaching stable operating conditions.

6. All equipment, interconnecting piping, and accessories are to be checked for leakage and specified rate performance capability. Instrumentation and controls shall be tested as part of the equipment they relate to.

G. Successful Tests: For a successful test of equipment or system, the equipment or system shall, in the Owner's sole discretion, operate trouble free for a continuous period of time as specified in PART 3 of this section. If there are any interruptions in operation during the test, the test shall be repeated until the equipment or system operates trouble free for the specified time period.

H. Contractor's, Manufacturer's, Engineer's and Owner's Responsibilities

1. Contractor:

a. Prepare and submit Test Procedures, Testing Schedule, and Manpower Schedule including all equipment items and systems.

b. Coordinate with equipment manufacturers, Owner, and Engineer to ensure presence of representatives during testing.

c. Furnish labor, unskilled and skilled, required for duration of the testing. Overtime wages, if necessary, shall be paid by the Contractor.

d. Provide power, water and other process materials and equipment required for specified testing.

e. Provide lubricants, fuel and chemicals as required for testing.

f. Conduct tests.

g. Prepare and submit Test Reports.

h. Coordinate testing with Engineer and Owner.

i. Make necessary changes, readjustment, repairs, and replacement at no additional cost to the Owner until final tests are acceptable to the Owner.

j. Provide materials, equipment, and services for permanent and temporary equipment and facilities required for conducting tests.

2. Manufacturer:

a. Supervise field tests of equipment and systems under provision of the individual specification section.

b. Inspect equipment onsite and complete and submit to the Owner a “Manufacturer's Field Services Report” for each type/style or differing model of equipment provided by the Manufacturer for the project.

c. Provide “Certificate of Proper Installation” for each type/style or differing model of equipment provided by the Manufacturer for the project following successful completion of the preliminary field tests.

3. Engineer:

a. Review and approve Testing Schedules

b. Review and approve Test Procedures.

c. Witness tests.

d. Review Test Reports.

e. Approve Test Results.

4. Owner:

a. Review and approve Testing Schedules

b. Review and approve Test Procedures.

c. Observe Tests.

d. Provide personnel as required for training under provision of Section 01600.

I. Conduct of Tests: Contractor shall coordinate with Owner and conduct required tests.

J. Contractor's Liabilities: Contractor shall be liable for, and shall neither have nor make any claim for:

1. Accidents occurring to Owners, Engineers and manufacturer's personnel during the tests;

2. Improper operation of equipment during tests and instruction periods;

3. Any damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

K. Testing Schedule

1. Perform all testing within the time periods designated in the construction schedule during regular weekday daytime working hours. Where possible testing shall occur Monday through Thursday. Monday and/or Friday testing shall be approved by the Owner a minimum of two (2) weeks prior to the proposed testing.

2. Update the test schedule monthly, or sooner if necessary, with the monthly schedule update until completion of the required testing.

3. Content of Testing Schedule

a. Proposed test dates,

b. Preliminary or final field test, equipment or system being tested,

c. Specification references,

d. Equipment identification numbers,

e. An indication of whether the test procedure has been submitted for approval and approved status.

L. Permission to Proceed: Contractor shall not proceed with any testing until the Final Field test procedures and the Manpower Schedule have been approved by the Engineer as specified herein. The Witnessing Engineer will personally authorize the start of a test.

M. Presence of Manufacturer's Representative(s): This is a prerequisite for the tests. No test shall be performed in the absence of the Manufacturer's Representative, who shall ensure his/her presence for the whole duration of the test.

N. Final Field Test Plans:

1. Final Field Test Plans shall include test procedures, testing schedule and manpower schedules for the tests of each equipment item or system are a prerequisite for the Field Tests.

2. Prepare and submit two copies of each test procedure not later than two weeks before the date of the test. A test procedure is required for each equipment item and for the facility as a whole.

3. Manpower Schedule, to be attached to each test procedure, shall specify number and qualifications of people to be present for the manufacturer(s), manufacturer's representatives and for the Contractor (unskilled and skilled labor).

O. Field Test Reports: Test Report Forms will be prepared by the Contractor for the Preliminary and Final field tests and submitted for Owner's and Engineer's approval 14 days prior to start of testing. The approved forms shall be used by the Contractor for data recording and notes during the tests. When the tests have been completed and accepted by the Engineer, the Contractor shall sign the Test Report; the witnessing Engineer will initial the report and take it with him/her for an analysis of the test data.

P. Test Failure

1. Correction Of Defects: Any defects in the equipment, or failure to meet the guarantees or performance requirements of the Specifications shall be promptly corrected by the Contractor by replacements and the minimum one (1) year guarantee period, or the guarantee period called for in the General Conditions, Article 14, Tests and Inspections; Correction, Removal or Acceptance of Defective Work, shall start after satisfactory replacement and successful completion of testing of the item.

2. If the Contractor fails to make the corrections called for in the above paragraph 1., or if the improved equipment fails again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for Work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at the Contractor's expense.

3. Repetition of the Tests: Unsuccessful test, regardless of the reason for test failure, shall be restarted and repeated until successful test completion. Resulting time delays and all additional expenses shall be accrued to the Contractor.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 PRELIMINARY (FUNCTIONAL) FIELD TESTS

A. Preliminary Field Tests: These tests shall be made with clean water, where practical, in lieu

of the wastewater components and chemicals for which the equipment and systems are designed.

1. Preliminary Field Tests of Equipment: Shall prove that equipment, appurtenances, and appliances meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration such as overheating, overloading, or vibration exceeding the limits specified in Section 11000, Basic Mechanical Requirements over the entire operating range.

    a. A successful preliminary field equipment test shall consist of at least two (2) continuous hours of trouble free operation of each of the two installed wastewater pumps and the conditioning pump at each site.

    b. The hours of continuous operation for successful preliminary field equipment test for the sewage pumps shall be without stopping and shall be measured by the equipment run times. Each pump shall be tested independently of the other pumps, and each wastewater pump and the conditioning pump at each site shall be run without stopping for two (2) hours.

2. Preliminary Field Tests of Systems:

    a. Following successful completion of preliminary field test of equipment, test all systems by operating the system equipment together as a unit with all related piping, valves, electrical controls and mechanical components.

    b. For a successful test, run each system with water and air trouble free for four (4) continuous hours.

3.02 FINAL (PERFORMANCE) FIELD TESTS

A. Final Field Tests shall be performed after a successful completion of the preliminary field tests.

B. Final Field Tests: These tests shall utilize the wastewater, wastewater components, chemicals, and air for which the equipment and systems are designed

1. Final Field Tests of Equipment: Shall prove that equipment, appurtenances, and appliances meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration.

C. Final Field Tests of Equipment: A successful test shall consist of at least two (2) continuous hours, or longer if so specified, of trouble free operation.

1. The hours of continuous operation for successful final field equipment test for the sewage pumps shall be without stopping and shall be measured by the equipment run times. Each pump shall be tested independently of the other pumps, and each wastewater pump and the conditioning pump at each site shall be run without stopping for two (2) hours.

D. Final Field Tests of Systems

1. Test all systems by operating the system equipment together as a unit with all related piping, valves, electrical controls and mechanical operation.

2. For a successful test, run each system trouble free for 15 consecutive days for each of the pump stations.

3.03 TESTING AND START-UP SEQUENCE

A. The Contractor is responsible for development and execution of the testing plans and schedules.

B. Successfully complete all pipe pressure testing per Section 15000 3.06, water-tightness testing of concrete structures per Section 02604, and equipment, electrical, instrumentation, and HVAC testing per equipment specifications, and preliminary testing in accordance with this section.

- END OF SECTION -

Attachment 01650

MANUFACTURER'S FIELD SERVICES REPORT

PROJECT NAME:	
PROJECT NUMBER:	
CONTRACT NUMBER:	
PROJECT DESCRIPTION:	
CONTRACTOR'S NAME:	

I am an experienced and authorized representative of the manufacturer of the following equipment:

Specification Section	Equipment Description

Initial each line as applicable:

	I am aware of the site storage conditions of the equipment and my field check indicates the method of storage has not adversely affected the equipment. (If not initialed, indicate reasons under Comments.)
	I have inspected, checked, and adjusted the equipment items named above. In my opinion, the equipment has been properly installed and lubricated, is in accurate alignment, and is free from any under stress imposed by connecting piping or anchor bolts.
	I have observed the operation of each item of equipment under full load conditions and, in my opinion, the equipment operated satisfactorily. (If not initialed, indicate reasons under Comments.)
	Initial operation was not observed (Initial the following statement which applies.)
	I want to be notified so that I may be present during initial operation of the equipment.
	It is not necessary that I be present for the initial operation of the equipment. My absence will not affect the manufacturer's warranty.
	Equipment installation is not complete at this time. (Indicate under Comments all items of work that must be completed before initial operation.)

Comments:

_____

_____

_____

_____

_____

_____

Distribution: ❑ Owner (original) ❑ Resident Project Representative ❑ Contractor ❑ Originator	Equipment Manufacturer's Name	
	Signature of Authorized Representative:	
	Date:	
	Printed Name:	
	Employer:	
	Address:	
	Telephone:	

SECTION 01700

PROJECT CLOSEOUT

PART 1 -- GENERAL

1.01 WORK INCLUDED

A. Procedures to be followed in achieving Substantial Completion and Final Completion of the Contract or defined portions thereof.

1.02 GENERAL

A. See Conditions of the Contract, and Division 1, General Requirements, which contain information and requirements that apply to the Work specified herein and are mandatory for this project.

B. Work specified herein shall be scheduled and coordinated with the progress of the Work as a whole.

1.03 PROJECT CLOSE OUT

A. As construction of the project enters the final stages of completion, the Contractor shall, in concert with accomplishing the requirements set forth in the Contract Documents, attend to or have already completed the following items as they apply to his contract:

1. Scheduling equipment manufacturers' visits to site.

2. Required testing in accordance with Section 01650, Start-Up and Field Testing.

3. Provide final operations and maintenance manuals and complete training of Owner’s personnel.

4. Attend to any other items listed herein or brought to the Contractor's attention by the Engineer.

B. Just before the Engineer's Certificate of Substantial Completion is issued, the Contractor shall accomplish the following as specified in the Specifications and as follows:

1. City of Winchester and regulatory agencies approval of the Work. It shall be the Contractor’s responsibility to schedule all Owner and other regulatory inspections and to comply with the requirements associated with the Work.

2. Complete startup and testing.

3. Submit test results of project components, certifications that equipment or materials are in compliance with Contract Documents.

4. Deliver special tools, spare parts, extra stock, and similar items.

5. Provide operations and maintenance manuals and complete training of Owner's personnel.

6. Correct or replace defective work, including completion of items previously overlooked or work which remain incomplete.

C. In addition, and before the Certificate of Substantial Completion is issued, the Contractor shall submit to the Owner certain records, certifications, etc., which are specified elsewhere in the Contract Documents. A partial list of such items appears below, but it shall be the Contractor's responsibility to submit any other items which are required in the Contract Documents:

1. Submit remaining contract closeout submittals including Record Drawings, Final Completion Photographs, damage or settlement surveys, property surveys, and similar final record information.

2. Any special guarantees or bonds (Submit to Owner).

3. Advise the Owner of pending insurance changeover requirements that will occur upon Final Completion.

4. Submit workmanship bonds, final certifications, and similar documents.

5. Copies of permit closeouts.

6. Touch up paint and otherwise repair and restore marred, exposed finishes.

7. Submit occupancy permits.

8. The Contractor's attention is directed to the fact that required certifications and information under Item 3 above, must actually be submitted earlier in accordance with other Sections of the Specifications.

D. The Contractor shall request and participate in a Substantial Completion Inspection with the Engineer and Owner. The purpose of the Substantial Completion Inspection is to jointly develop a list of incomplete work items and develop the punchlist.

1.04 FINAL COMPLETION

A. The Contract will not be considered finally complete until all of the following have been submitted and approved by the Engineer as required in Section 01300, Submittals, and other portions of the Contract Documents.

1. Final Operations and Maintenance Manuals and Warranty documentation submittals.

2. Construction photographs and recordings, including Final Completion Photographs.

3. Certified copy of the final punchlist. The certified copy shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Engineer.

4. Final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.

5. An updated final statement, accounting for final additional changes to Contract Sum.

6. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of Work.

7. Consent of surety to Final Payment.

8. Evidence of final, continuing insurance coverage complying with insurance requirements.

9. Final liquidated damages settlement statement (if applicable).

10. Complete and verifiable Contract Closeout Submittals satisfactory to the Engineer.

11. Complete additional final cleaning.

12. Final survey

13. The Contract will not be considered finally complete until all guarantees, bonds, permits, certifications, licenses, and affidavits required for Work or Equipment as specified are filed with and approved by the Engineer.

B. Final Inspection

1. The purpose of the Final Inspection shall be to review and verify the completion of all final punchlist items.

2. Final cleaning and repairing shall be so arranged as to be finished upon completion of the construction work. The Contractor will make his final cleaning and repairing, and any portion of the work finally inspected and accepted by the Engineer shall be kept clean by the Contractor, until the final acceptance of the entire work.

3. When the Contractor has finally cleaned and repaired the whole or any portion of the work, he shall notify the Engineer that he is ready for final inspection of the whole or a portion of the work, and the Engineer will thereupon inspect the work. If the work is not found satisfactory, the Engineer will order further cleaning, repairs, or replacement.

4. When such further cleaning or repairing is completed, the Engineer, upon further notice, will again inspect the work. The "Final Payment" will not be processed until the Contractor has complied with the requirements set forth, and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is properly and satisfactorily constructed in accordance with the requirements of the Contract Documents.

C. Final Cleaning

1. At the completion of the work, the Contractor shall remove all rubbish from and about the site of the work, and all temporary structures, construction signs, tools, scaffolding, materials, supplies and equipment which he or any of his Subcontractors may have used in the performance of the work. Contractor shall broom clean paved surfaces and rake clean other surfaces of grounds.

2. Contractor shall maintain cleaning until project, or portion thereof, is occupied by the Owner.

3. Before finally leaving the site, the Contractor shall wash and clean all exposed surfaces which have become soiled or marked, and shall remove from the site of work all accumulated debris and surplus materials of any kind which result from his operation, including construction equipment, tools, sheds, sanitary enclosures, etc. The Contractor shall leave all equipment, fixtures, and work, which he has installed, in a clean condition. The completed project shall be turned over to the Owner in a neat and orderly condition.

   a. Clean all glass and adjust all windows and doors for proper operation.

   b. Clean all finish hardware after adjustment for proper operation.

   c. Touch up marks or defects in painted surfaces and touch up any similar defects in factory finished surfaces.

   d. Wax all resilient flooring materials.

   e. Remove bitumen from gravel stops, fascias, and other exposed surfaces.

   f. Remove all stains, marks, fingerprints, soil, spots, and blemishes from all finished surfaces, tile, stone, brick, and similar surfaces

4. The site of the work shall be rehabilitated or developed in accordance with other sections of the Specifications and the Drawings. In the absence of any portion of these requirements, the Contractor shall completely rehabilitate the site to a

condition and appearance equal or superior to that which existed just prior to construction, except for those items whose permanent removal or relocation was required in the Contract Documents or ordered by the Owner.

1.05 FINAL SURVEY

A. Provide an as-built site plan prepared by a licensed Land Surveyor or licensed Professional Engineer, registered in the Commonwealth of Virginia, prepare the submission and make all corrections and additions required to obtain approval from the Engineer. Partial listing of requirements for as-built site plan submission:

1. Boundary of the site.

2. All structures.

3. All storm sewer, sanitary sewer, manholes, inlet structures, and fire hydrants, showing pipe sizes, lengths, top and invert elevations and percent slope of pipe.

4. All electric and communication utilities.

5. Deed book and page number of any dedication and all easements.

6. Certification by the engineer or surveyor indicating that the as-builts represents the actual conditions on the site and bearing his signature and Virginia registration number.

7. Any other pertinent information as determined by the Owner or Engineer.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 02100

CLEARING, GRUBBING, AND SITE PREPARATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Includes all labor, material, equipment and appliances required for the complete execution of any additions, modifications, or alterations to existing building(s) and new construction work as shown on the Drawings and specified herein.

B. Principal items of work include:

1. Notifying all authorities owning utility lines running to or on the property. Protecting and maintaining all utility lines to remain and capping those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.

2. Clearing the site within the Limits of Disturbance, including removal of grass, brush, shrubs, trees, loose debris and other encumbrances except for trees marked to remain.

3. Boxing and protecting all trees, shrubs, lawns and the like within areas to be preserved. Relocating trees and shrubs, so indicated on the Drawings, to designated areas.

4. Repairing all injury to trees, shrubs, and other plants caused by site preparation operations shall be repaired immediately. Work shall be done by qualified personnel in accordance with standard horticultural practice and as approved by the Engineer.

5. Removing topsoil to its full depth from designated areas and stockpiling on site where directed by the Owner for future use.

6. Disposing from the site all debris resulting from work under this Section in a properly permitted facility.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Virginia Administrative Code, Title 9, Agency 15.

1.04 STREET AND ROAD BLOCKAGE

A. Closing of streets and roads during progress of the work shall be in compliance with the requirements of the Owner, VDOT and other authorities having jurisdiction. Access shall be provided to all facilities remaining in operation at all times.

1.05 PROTECTION OF PERSONS AND PROPERTY

A. All work shall be performed in such a manner to protect all personnel, workmen, pedestrians and adjacent property and structures from possible injury and damage.

B. All conduits, wires, cables and appurtenances above or below ground shall be protected from damage.

C. Provide warning and barrier fence as required.

PART 2 -- EXECUTION

2.01 CLEARING OF SITE

A. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shall be cleared and grubbed.

B. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, sanitary landfill material, fencing, and other perishable and objectionable material within the areas to be excavated or other designated areas. Should it become necessary to remove a tree, bush, brush or other plants adjacent to the area to be excavated, the Design/Builder shall do so only after permission has been granted by the Owner.

C. Excavation resulting from the removal of trees, roots and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02200 - Earthwork.

D. Unless otherwise shown or specified, the Design/Builder shall. clear and grub a strip at least 15 ft. wide along all permanent fence lines installed under this Contract.

E. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Owner.

2.02 STRIPPING AND STOCKPILING EXISTING TOPSOIL

A. Existing topsoil and sod on the site within areas designated on the Drawings shall be stripped to whatever depth it may occur.

B. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling the topsoil.

C. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

2.03 GRUBBING

A. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks and other perishable materials to a depth of at least 6-inches below ground surfaces.

B. Large stumps located in areas to be excavated shall be removed during grading operations.

2.04 DISPOSAL OF MATERIAL

A. All debris resulting from the clearing and grubbing work shall be disposed of by the Design/Builder at a properly permitted location as part of the work of this Contract. Material designated by the Owner to be salvaged shall be stored on the construction site as directed by the Owner for reuse in this Project or removal by others.

B. Burning of any debris resulting from the clearing and grubbing work will not be permitted at the site.

2.05 WARNING AND BARRIER FENCE

A. The fence shall be made of a visible, lightweight, flexible, high strength polyethylene material. The fence shall be Beacon Plus High Visibility Orange Safety Fence as manufactured by TENAX, or equal.

B. Physical Properties

Fence:

Color:	International Orange
Roll Size:	4' x 164'
Roll weight:	34 lbs.
Mesh opening:	1-1/2" x 3-1/2"

Posts:

ASTM Designation:	ASTM 702
Length:	5 feet long (T-Type)
Weight:	1.25 #/Foot (min)
Area of Anchor Plate:	14 Sq. In.

C. Drive posts 18 inches into ground every 10'. Wrap fence material around first terminal post allowing overlap of one material opening. Use metal tie wire or plastic tie wrap to fasten material to itself at top, middle and bottom. At final post, cut with utility knife or scissors at a point halfway across an opening. Wrap around and tie at final post in the same way as the first post.

D. Use tie wire or tie wrap at intermediate posts and splices as well. Thread ties around a vertical member of the fence material and the post and bind tightly against the post. For the most secure fastening, tie at top, middle and bottom. Overlap splices a minimum of four fence openings, tie as above, fastening both edges of the fence material splice overlap.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 02200

EARTHWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment and materials required to complete all work associated with excavation, including off-site borrow excavation, dewatering, backfill, drainage layers beneath and around structures, foundation and backfill stone, filter fabric, embankments, stockpiling topsoil and any excess suitable material in designated areas, in place compaction of embankments, backfill and subgrades beneath foundations and roadways, excavation support, disposing from the site all unsuitable materials, providing erosion and sedimentation control grading, site grading and preparation of pavement and structure subgrade, and other related and incidental work as required to complete the work shown on the Drawings and specified herein. The Contractor shall be responsible for all excavation, including backfilling and conduit encasement.

B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.

C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.

D. All work under this Contract shall be done in conformance with and subject to the limitations of the latest editions of the Virginia Department of Transportation 2016 Road and Bridge Specification Book, the Virginia Erosion and Sediment Control Handbook (VESCH), Third Edition, 1999 or latest, and the requirements of the City of Winchester and Frederick County Erosion and Sediment Control Programs.

E. All fill material, processed stone, topsoil, etc. imported to the site and onsite material requested to be used shall be subjected to the testing requirements contained in Part 3 of this section. An independent testing laboratory retained by the Contractor shall perform all testing. Certified test results will determine if a material meets the Sections. The Contractor shall furnish all necessary samples for laboratory test and shall provide assistance and cooperation during field tests. The Contractor shall plan his operations to allow adequate time for laboratory tests and to permit taking of field density tests during compaction. Any costs of retesting required as a result of failure to meet compaction requirements shall be borne by the Contractor.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

32414-000

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Department of Transportation 2016 Road and Bridge Specification Book.

2. American Society for Testing and Materials (ASTM):

ASTM C 127	Test for Specific Gravity and Absorption of Coarse Aggregate.
ASTM C 136	Test for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 422	Particle Size Analysis of Soils.
ASTM D 423	Test for Liquid Limit of Soils.
ASTM D 424	Test for Plastic Limit and Plasticity Index of Soils.
ASTM C 535	Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM D 698	Standard Method of Test for the Moisture - Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12-inch (305 mm) Drop.
ASTM D1556	Test for Density of Soil in Place by the Sand-Cone Method.
ASTM D1557	Test for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lbs. (4.5 kg) Rammer and 18-inch (457 mm) Drop.
ASTM D2049	Test Method for Relative Density of Cohesionless Soils.
ASTM D2167	Test for Density of Soil in Place by the Rubber-Balloon Method.
ASTM D2216	Test for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.
ASTM D2487	Test for Classification of Soils for Engineering Purposes.
ASTM D2922	Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.04 SUBSURFACE CONDITIONS

A. Information on subsurface conditions is referenced under Division 1, General Requirements.

B. Attention is directed to the fact that there may be water pipes, storm drains and other utilities located in the area of proposed excavation. Perform all repairs to same in the event that excavation activities disrupt service. The Contractor shall contact Choose an item.Va.811.com at 1-800-552-7001 to request underground utility location mark-out at least two (2) working days, not including the day the request is called in, but no more than ten (10) working days prior to the beginning of excavation. The Contractor shall also contact and request utility location mark-out from buried utility owners with utilities on the project site that are not participants of Va.811.com.

1.05 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.

3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

4. Plans and cross sections of open cut excavations showing side slopes and limits of the excavation at grade.

5. Construction drawings and structural calculations for any types of excavation support required. Drawings and calculations shall be sealed by a currently registered Professional Engineer in the Commonwealth of Virginia.

6. Monitoring plan and pre-construction condition inspection and documentation of all adjacent structures, utilities, and roadways near proposed installation of excavation support systems.

7. Dewatering procedures shall be in accordance with Section 3.06 of this Specification.

8. The Contractor shall notify the Engineer of the off-site or on-site sources of structural fill and submit to the Engineer a representative sample weighing approximately 50 lbs. The sample shall be delivered to a location designated by the Engineer.

1.06 PRODUCT HANDLING

A. Soil and rock material shall be excavated, transported, placed, and stored in a manner so as to prevent contamination, segregation and excessive wetting. Materials which have become contaminated or segregated will not be permitted in the performance of the work and shall be removed from the site.

PART 2 -- PRODUCTS

2.01 SELECT FILL

A. Soils from the excavations meeting requirements in this section with the exceptions of topsoil and organic material may be used as Select Fill for backfilling, constructing embankments, reconstructing existing embankments, and as structural subgrade support, respectively.

B. Select Fill shall be well-graded, and free of lumps larger than 3 inches, rocks larger than 3 inches and unsuitable material. Backfill against walls shall not contain any rock larger than ½-inches.

C. Aggregate used as Select Fill shall consist of sandy gravel or gravelly sand, free of organic material, environmental contaminants, snow, ice, frozen soil, or other unsuitable material, and be well-graded within the following limits:

U.S. Standard Sieve Size	Percent Finer by Weight
3 in.	100
No. 4	30-80
No. 40	10-50
No. 200	0-8

D. Select fill used for backfilling around and over pipe shall either be material as described above or a granular soil material with a Maximum Plasticity Index (PI) of 6.

E. Regardless of material used as select fill, select fill materials shall be compacted at a moisture content satisfactory to the Engineer, which shall be approximately that required to produce the maximum density except that the moisture content shall not be more than 1% below nor more than 4% above the optimum moisture content for the particular material tested in accordance with the ASTM D698.

F. Aggregate used as Select Fill for subgrade support shall be a coarse aggregate material meeting the gradation requirements of #57 or #67 aggregates in accordance with ASTM C-33, or Aggregate Base Material (ABM) as defined in Section 02207 – Aggregate Materials.

G. Where excavated material does not meet requirements for Select Fill, Contractor shall furnish off-site borrow material meeting the specified requirements herein. Determination of whether the borrow material will be paid for as an extra cost will be made based on the contract documents.

H. When the excavated material from required excavations is suitable for use as backfill, bedding, or embankments, but is replaced with off-site borrow material for the Contractor's convenience, the costs associated with such work and material shall be borne by the Contractor.

I. Contractor shall stockpile on site in areas designated in the Contract Documents to avoid hauling material offsite unless contaminated. No stockpiling of excavated material would

be allowed in a manner or location that would permit erosion and its subsequent sedimentation in wetlands or other natural areas.

2.02 TOPSOIL

A Topsoil shall be considered the surface layer of soil and sod, suitable for use in seeding and planting. It shall contain no mixture of refuse or any material toxic to plant growth.

2.03 GEOTEXTILES

A. The Contractor shall provide geotextiles as indicated on the Drawings and specified herein. The materials and placement shall be as indicated under Section 02274 - Geotextiles.

PART 3 -- EXECUTION

3.01 STRIPPING OF TOPSOIL

A. In all areas to be excavated, filled, paved, or graveled the topsoil shall be stripped to its full depth, not less than four (4) inches below the ground surface, and shall be deposited in storage piles on the site, at locations designated by the Engineer, for subsequent reuse. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials. Topsoil shall not be stored in areas where it will interfere with surface drainage or with the conservation of trees, shrubs and other vegetation that are to remain.

3.02 EXCAVATION

A. All material excavated, regardless of its nature or composition, shall be classified as UNCLASSIFIED EXCAVATION. Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, buried concrete, brick, and all other obstacles encountered and shown to be removed within the limits of excavation shown on the Drawings or specified herein. The cost of excavation shall be included in the Lump Sum Bid Price and no additional payment will be made for the removal of obstacles encountered within the excavation limits shown on the Drawings and specified herein.

B. All suitable material removed in the excavation shall be used as far as practicable in the formation of embankments, subgrades, and shoulders, and at such other places as may be indicated on the Drawings or indicated by the Engineer. No excavation shall be wasted except as may be permitted by the Engineer. Refer to the drawings for specific location and placement of suitable excavated materials in the formation of embankments, backfill, and structural and roadway foundations. THE ENGINEER WILL DESIGNATE MATERIALS THAT ARE UNSUITABLE. The Contractor shall furnish off-site disposal areas for the unsuitable material. Where suitable materials containing excessive moisture are encountered above grade in cuts, the Contractor shall construct above grade ditch drains prior to the excavation of the cut material when in the opinion of the Engineer such measures are necessary to provide proper construction.

C. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping and for such excavation support, pumping and drainage as may be required. Excavation shall be made in accordance with the grades and details shown on the Drawings and as specified herein.

D. Excavation slopes shall be flat enough to avoid slides that will cause disturbance of the subgrade or damage of adjacent areas. Excavation requirements and slopes shall be as indicated in the Drawings. The Contractor shall intercept and collect surface runoff both at the top and bottom of cut slopes. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded as shown on the Drawings or as may be indicated by the Engineer. Concurrent with the excavation of cuts, the Contractor shall construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the Drawings or designated by the Engineer. All slopes shall be finished to reasonably uniform surfaces acceptable for seeding and mulching operations. No rock or boulders shall be left in place which protrude more than 1 foot within the typical section cut slope lines, and all rock cuts shall be cleaned of loose and overhanging material. All protruding roots and other objectionable vegetation shall be removed from slopes. The Contractor shall be required to submit plans of open-cut excavation for review by the Engineer before approval is given to proceed.

E. It is the intent of these Specifications that all structures shall bear on an aggregate base, crushed stone or screened gravel bedding placed to the thickness shown on the Drawings, specified in these Specifications, or not less than 6-inches. Bedding for process piping shall be as shown on the Drawings.

F. The bottom of all excavations for structures and pipes shall be examined by the Engineer for bearing value and the presence of unsuitable material. If, in the opinion of the Engineer, additional excavation is required due to the low bearing value of the subgrade material, or if the in-place soils are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, and/or crushed stone or screened gravel as indicated by the Engineer. Payment for such additional work ordered by the Engineer shall be made as an extra by a Change Order in accordance with the General Conditions and Division 1. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.

G. All cuts shall be brought to the grade shown on the Drawings, or established by the Engineer, prior to final inspection and acceptance by the Engineer.

H. Slides and overbreaks which occur due to negligence, carelessness or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as indicated by the Engineer at no additional cost to the Owner. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed.

I. Where the excavation exposes sludge, sludge contaminated soil or other odorous materials, the Contractor shall cover such material at the end of each workday with a

minimum of 6-inches and a maximum of 24-inches of clean fill. The work shall be an odor abatement measure and the material shall be placed to the depth deemed satisfactory by the Engineer for this purpose.

3.03 UNAUTHORIZED EXCAVATION

A. Excavation carried outside of the work limits required by the Contract Documents shall be at the Contractor's expense, and shall be backfilled by the Contractor at its own expense with suitable material, as directed by the Engineer. Where, in the judgment of the Engineer, such over-excavation requires use of lean concrete or crushed stone, the Contractor, at its expense shall furnish and place such materials.

3.04 EXCAVATION SUPPORT

A. The Contractor shall furnish, place, and maintain such excavation support which may be required to support sides of excavation or to protect structures, pipes, and utilities from possible damage and to provide safe working conditions. The Contractor shall be exclusively responsible for maintaining structure integrity without overstressing and damaging existing structures, pipes, and utilities resulting from the Contractor's desires to temporarily place, move, or remove loads on or adjacent to existing structures, pipes, and utilities. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor. The Contractor shall be responsible for the adequacy of all supports used and for all damage resulting from failure of support system or from placing, maintaining and removing it.

B. Selection of and design of any proposed excavation support systems is exclusively the responsibility of the Contractor. Contractor shall submit drawings and calculations on proposed systems sealed by a Professional Engineer currently registered in the Commonwealth of Virginia.

C. The Contractor shall exercise caution in the installation and removal of supports to insure no excessive or unusual loadings or vibrations are transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to installation or removal of excavation support system.

D. Contractor shall monitor movement and vibration in the excavation support systems as well as movement and vibration at adjacent structures, utilities and roadways near excavation supports. Contractor shall submit a monitoring plan developed by the excavation support design engineer. All pre-construction condition assessment and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. If any sign of distress such as cracking or movement occurs in any adjacent structure, utility or roadway during installation of supports, subsequent excavation, service period of supports, subsequent backfill and construction, or removal of supports, Engineer shall be notified immediately. Contractor shall be exclusively responsible for any damage to any roadway, structure, utility, pipes, etc. both on-site and off-site, as a result of his operations.

E. All excavation supports shall be removed upon completion of the work except as indicated herein. The Engineer may permit supports to be left in place at the request and expense

of the Contractor. The Engineer may order certain supports left permanently in place in addition to that required by the Contract. The cost of the materials so ordered left in place, less a reasonable amount for the eliminated expense of the removal work omitted, will be paid as an extra by a Change Order in accordance with the General Conditions and Division 1. Any excavation supports left in place shall be cut off at least two (2) feet below the finished ground surface or as directed by the Engineer.

3.05 PROTECTION OF SUBGRADE

A. To minimize the disturbance of bearing materials and provide a firm foundation, the Contractor shall comply with the following requirements:

1. Use of heavy rubber-tired construction equipment shall not be permitted on the final subgrade unless it can be demonstrated that drawdown of groundwater throughout the entire area of the structure is at least 3 feet below the bottom of the excavation (subgrade). Even then, the use of such equipment shall be prohibited should subgrade disturbance result from concentrated wheel loads.

2. Subgrade soils disturbed through the operations of the Contractor shall be excavated and replaced with compacted select fill or crushed stone at the Contractor's expense as directed by the Engineer.

3. The Contractor shall provide positive protection against penetration of frost into materials below the bearing level during work in winter months. This protection can consist of a temporary blanket of straw or hay covered with a plastic membrane or other acceptable means.

3.06 PROOFROLLING

A. The subgrade of all structures and all areas that will support pavements or select fill shall be proofrolled. After stripping of topsoil, excavation to subgrade and prior to placement of fills, the exposed subgrade shall be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft, or loose soil, and other undesirable materials shall be removed. The exposed subgrade shall be proofrolled with a heavily loaded tandem-wheeled dump truck to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed shall be removed and replaced with an approved compacted material.

3.07 DEWATERING

A. The Contractor shall do all dewatering as required for the completion of the work. Procedures for dewatering proposed by the Contractor shall be submitted to the Engineer for review prior to any earthwork operations. All water removed by dewatering operations shall be disposed of in accordance with the Virginia State Water Control Act.

B. The dewatering system shall be of sufficient size and capacity as required to control groundwater or seepage to permit proper excavation operations, embankment construction and reconstruction, subgrade preparation, and to allow concrete to be placed in a dry condition. The system shall include a sump system or other equipment, appurtenances and other related earthwork necessary for the required control of water.

The Contractor shall drawdown groundwater to at least 3 feet below the bottom of excavations (subgrade) at all times in order to maintain a dry and undisturbed condition.

C. The Contractor shall control, by acceptable means, all water regardless of source. Water shall be controlled and its disposal provided for at each berm, structure, etc. The entire periphery of the excavation areas shall be ditched and diked to prevent water from entering the excavation. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional expense to the Owner. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.

D. The Contractor shall be responsible for and shall repair without cost to the Owner, any damage to work in place and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area. The Contractor shall be responsible for damages to any other area or structure caused by his failure to maintain and operate the dewatering system proposed and installed by the Contractor.

E. The Contractor shall take all the steps that he considers necessary to familiarize himself with the surface and subsurface site conditions, and shall obtain the data that is required to analyze the water and soil environment at the site and to assure that the materials used for the dewatering systems will not erode, deteriorate, or clog to the extent that the dewatering systems will not perform properly during the period of dewatering. Copies of logs of borings and laboratory test results are available to the Contractor. This data is furnished for information only, and it is expressly understood that the Owner and Engineer will not be held responsible for any interpretations or conclusions drawn therefrom by the Contractor.

F. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of adjoining structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

3.08 EMBANKMENTS

A. The Contractor shall perform the construction of embankments in such a manner that cut and fill slopes will be completed to final slopes and grade in a continuous operation. The operation of removing excavation material from any cut and the placement of embankment in any fill shall be a continuous operation to completion unless otherwise permitted by the Engineer.

B. Surfaces upon which embankments are to be constructed shall be stripped of topsoil, organic material, rubbish and other extraneous materials. After stripping and prior to placing embankment material, the Contractor shall compact the top 12-inches of in place soil as specified under Paragraph 3.10, COMPACTION.

C. Any soft or unsuitable materials revealed before or during the in place compaction shall be removed as indicated by the Engineer and replaced with select fill.

D. Ground surfaces on which embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the embankment with the existing surface. The

embankment soils shall be as specified under Part 2 - Products, and shall be deposited and spread in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width of the cross section, and shall be kept approximately level by the use of effective spreading equipment. Hauling shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form during the construction of the embankment. The embankment shall be properly drained at all times. Each layer of the embankment shall be thoroughly compacted to the density specified under Paragraph 3.10, COMPACTION.

E. The embankment or fill material in the layers shall be of the proper moisture content before rolling to obtain the prescribed compaction. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken at frequent intervals. From these tests, corrections, adjustments, and modifications of methods, materials, and moisture content will be made to construct the embankment.

F. Where embankments are to be placed and compacted on hillsides, or when new embankment is to be compacted against embankments, or when embankment is built in part widths, the slopes that are steeper than 4:1 shall be loosened or plowed to a minimum depth of 6 inches or, if in the opinion of the Engineer, the nature of the ground is such that greater precautions should be taken to bind the fill to the original ground then benches shall be cut in the existing ground as indicated by Engineer.

G. When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portions of the embankments and the other material which meets the requirements for select fill shall be incorporated into the formation of the embankments. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the final grade. Stones, fragmentary rock, or boulders larger than 12-inches in their greatest dimension will not be allowed in any portions of embankments and shall be disposed of by the Contractor as indicated by the Engineer. When rock fragments or stone are used in embankments, the material shall be brought up in layers as specified or directed and every effort shall be exerted to fill the voids with finer material to form a dense, compact mass which meets the densities specified for embankment compaction.

3.09 BACKFILLING

A. All structures and pipes shall be backfilled with the type of materials shown on the Drawings and specified herein. Select fill shall be deposited in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the ground nor within 6 inches of pipes. No stone or fragmentary rock larger than 12-inches in their greatest dimension will be allowed for any portion of backfill. Compaction shall be in accordance with the requirements of Paragraph 3.10, COMPACTION.

B. Where excavation support is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when supports are removed. If significant volumes of soil cannot be prevented from clinging to the extracted supports, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that supports will be installed in similar soil conditions or employ other appropriate means to prevent loss of support.

C. Backfill against concrete or masonry structure shall not be performed until the Work has been reviewed and backfilling permitted. Backfill against walls shall also be deferred until the structural slab for floors above the top fill line have been placed and attained design strength or earlier at the discretion of the Engineer. Partial backfilling against adequately braced wall may be considered by the Engineer on an individual situation basis. Where walls are to be waterproofed, all Work shall be completed and membrane materials dried or cured according to the manufacturer's instructions before backfilling.

D. Backfill against tanks and other structures which are to retain liquids shall not be performed until leakage tests are completed and accepted by the Engineer in accordance with the Section entitled "Water Tightness Testing".

3.10 COMPACTION

A. The Contractor shall compact embankments, backfill, crushed stone, aggregate base, and in place subgrade in accordance with the requirements of this Section. The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

	Density % Std. Proctor (D698)	Density % Mod. Proctor (D1557)	Max. Lift Thickness as Compacted Inches
Embankments Beneath Structures*	98	95	8
Other Embankments	95	92	8
Backfill Around Structures	95	92	8
Backfill in Pipe Trenches	95	92	8
Crushed Stone Beneath Structures	**	**	12
Select Sand	--	98	8
Crushed Stone Backfill	**	**	12
Crushed Stone Pipe Bedding	**	**	12
In place Subgrade Beneath Structures	98	95	Top 12-inches

* Embankments beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45 degree slope.

** The aggregate shall be compacted to a degree acceptable to the Engineer by use of a vibratory compactor and/or crawler tractor.

B. Compaction Near Existing Structures:

1. Vibratory equipment shall not be used within 25 feet of any existing structure.

2. Within 25 feet of any existing structure, non-vibratory compaction equipment such as a drum roller with a maximum weight of 4 tons should be used. Within 5 feet of any existing structure, a walk behind vibratory sled or roller shall be used.

C. Field density tests will be made by the Engineer to determine if the specified densities have been achieved, and these tests shall be the basis for accepting or rejecting the compaction. In-place density tests will be performed in accordance with ASTM D1556, ASTM D2167, or ASTM D6938. The Engineer will be the sole judge as to which test method will be the most appropriate. Failure to achieve the specified densities shall require the Contractor to re-compact the material or remove it as required. The Contractor shall, if necessary, increase his compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the layer thickness. The Contractor shall adjust the moisture contents of the soils to bring them within the optimum range by drying them or adding water as required.

D. Testing shall be performed at a minimum frequency of one in-place density test for each 1000 cubic yards of embankment placed and 500 cubic yards of backfill placed or one test performed each day for either.

3.11 VIBRATION MONITORING

A. Vibration monitoring shall be performed at nearby structures when compaction work is ongoing. A single monitoring point using vibration monitoring equipment capable of detecting velocities of 0.1 inch/second or less and survey measurements shall be used for vibration monitoring at each of the nearest structures. An elevation measurement on nearby structures shall be taken before compaction work starts, and then at least twice a day during the work with one reading taken at the conclusion of the day's operations. Elevation measurements shall be recorded to an accuracy of 0.001 foot. If at any time the Contractor detects settlement or heave of 0.005-feet or more, or vibration levels of 0.5 inch/second or more, the vibratory compaction shall be stopped immediately and the Engineer notified.

3.12 REMOVAL OF EXCESS AND UNSUITABLE MATERIALS

A. The Contractor shall remove and dispose of off-site all unsuitable materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Engineer for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property, the submittal shall also include written permission from the owner of record.

B. All unsuitable materials shall be disposed of in locations and under conditions that comply with federal, state and local laws and regulations.

C. The Contractor shall obtain an off-site disposal area prior to beginning demolition or excavation operations.

D. All excess and unsuitable materials shall be hauled in trucks of sufficient capacity and tight construction to prevent spillage. Trucks shall be covered to prevent the propagation of dust.

E. When all excess and unsuitable material disposal operations are completed, the Contractor shall leave the disposal sites in a condition acceptable to the Owner and Owner(s) of the disposal site(s).

3.13 BORROW EXCAVATION

A. Description

The work covered by this section consists of the excavation of approved material from borrow sources and the hauling and utilization of such material as required on the Drawings or directed by the Engineer. It shall also include the removing, stockpiling, and replacement of topsoil on the borrow source; the satisfactory disposition of material from the borrow source which is not suitable for use; and the satisfactory restoration of the borrow source and haul roads to an acceptable condition upon completion of the work.

Borrow excavation shall not be used before all available suitable unclassified excavation has been used for backfill and incorporated into the embankments.

B. Coordination with Seeding Operations

The Contractor shall coordinate the work covered by this section with the construction of embankments so that the requirements of Section 02200 are met.

C. Materials

All material shall meet the requirements of Section 02207 – Aggregate Materials.

D. Construction Methods

1. General

The surface of the borrow area shall be thoroughly cleared and grubbed and cleaned of all unsuitable material including all organics, topsoil, etc., before beginning the excavation. Disposal of material resulting from clearing and grubbing shall be in accordance with Section 02100 – Clearing and Grubbing.

Each borrow operation shall not be allowed to accumulate exposed, erodible slope area in excess of 1 acre at any one given time without the Contractor's beginning permanent seeding and mulching of the borrow source or other erosion control

measures as may be approved by the Engineer.

The topsoil shall be removed and stockpiled at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Temporary erosion control measures shall be installed as may be necessary to prevent the erosion of the stockpile material. Once all borrow has been removed from the source or portion thereof, the stockpiled topsoil shall be spread uniformly over the source.

Where it is necessary to haul borrow material over existing roads, the Contractor shall use all necessary precautions to prevent damage to the existing roads. The Contractor shall also conduct his hauling operations in such a manner as to not interfere with the normal flow of traffic and shall keep the traffic lanes free from spillage at all times.

2. Owner Furnished Sources

Where borrow sources are furnished by the Owner the location of such sources will be as designated on the Drawings or as directed by the Engineer.

The Owner will furnish the necessary haul road right-of-way at locations designated by the Engineer. All haul roads required shall be built, maintained, and when directed by the Engineer, obliterated, at no cost to the Owner. Where the haul road is to be reclaimed for cultivation the Contractor shall plow or scarify the area to a minimum depth of 8 inches.

The borrow sources shall be left in a neat and presentable condition after use. All slopes shall be smoothed, rounded, and constructed not steeper than 3:1. Where the source is to be reclaimed for cultivation the source shall be plowed or scarified to a minimum depth of 8 inches, disc harrowed, and terraces constructed. The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided.

All sources shall be seeded and mulched in accordance with Section 02910.

3. Contractor Furnished Sources

Prior to the approval of any off-site borrow source(s) developed for use on this project, the Contractor shall obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the removal of the borrow material from the borrow source(s) will have no effect on any known district, site building, structure, or object that is included or eligible for inclusion in the National Register of Historic Places. A copy of this certification shall be furnished to the Engineer prior to performing any work on the proposed borrow source.

The approval of borrow sources furnished by the Contractor shall be subject to the following conditions:

a. The Contractor shall be responsible for acquiring the right to take the material and any rights of access that may be necessary; for locating and developing the source; and any clearing and grubbing and drainage ditches necessary.

Such right shall be in writing and shall include an agreement with the Owner that the borrow source may be dressed, shaped, seeded, mulched, and drained as required by these Specifications after all borrow has been removed.

b. Except where borrow is to be obtained from a commercial source, the Contractor and the property owner shall jointly submit a borrow source development, use, and reclamation plan to the Engineer for his approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary. The Contractor's plan shall address the following:

i. Drainage

The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided. If drainage is not practical, and the source is to serve as a pond, the minimum average depth below the water table shall be 4 feet or the source graded so as to create wetlands as appropriate.

ii. Slopes

The source shall be dressed and shaped in a continuous manner to contours which are comparable to and blend in with the adjacent topography, but in no case will slopes steeper than 3:1 be permitted.

iii. Erosion Control

The plan shall address the temporary and permanent measures that the Contractor intends to employ during use of the source and as a part of the reclamation. The Contractor's plan shall provide for the use of staged permanent seeding and mulching on a continual basis while the source is in use and the immediate total reclamation of the source when no longer needed.

4. Maintenance

During construction and until final acceptance the Contractor shall use any methods approved by the Engineer which are necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion.

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SECTION 02207

AGGREGATE MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish all labor, equipment and materials required to complete all work associated with the installation of aggregate material beneath foundations, as backfill and as roadway subgrades and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork

B. Section 02276 – Erosion and Sediment Control

C. Section 02910 – Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Department of Transportation Road and Bridge Specifications, and applicable special provisions and copied notes.

2. ASTM C 127 Test for Specific Gravity and Absorption of Coarse Aggregate.

3. ASTM C 131 Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

4. ASTM C 136 Test for Sieve Analysis of Fine and Coarse Aggregates.

5. ASTM C 535 Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittal Procedures.

1. Materials gradation and certification.

2. ASTM C127, ASTM C136, and ASTM C535 test results

PART 2 -- PRODUCTS

2.01 CRUSHER RUN, SELECT FILL, AND SCREENED GRAVEL

A. Aggregate used for Select Fill or screened gravel shall meet the requirements of Aggregate Standard Size No. 57 or No. 67 as defined by Section 203 of the VDOT Standard Specifications.

B. Crusher Run shall be as defined by Section 205 of the VDOT Standard Specifications.

2.02 SELECT SAND

A. Select sand shall meet the requirements of Section 202 of the VDOT Road and Bridge Specifications for materials and gradation. The size used shall be Standard Size No. 2A or 2B as listed and defined in Table 11-1, "Fine Aggregate", of the VDOT Road and Bridge Specifications.

2.03 CHOKER STONE

A. Choker stone shall be clean, washed No. 8 stone meeting the requirements of ASTM D448.

2.04 GRAVEL DRAINAGE LAYER

A. Stone for the gravel drainage layer stone shall be clean, washed No. 2 stone (3 inch to ¾ in size) meeting the requirements of ASTM D448.

PART 3 -- EXECUTION

3.01 CRUSHER RUN AND SCREENED GRAVEL

A. Design/Builder shall install crusher run and screened gravel in accordance with the VDOT Road and Bridge Specifications and as shown on the Drawings and indicated in the Contract Documents.

1. Unless otherwise stated herein or shown on the Drawings, all mat foundations (bottom slabs) for the proposed structures shall have a blanket of screened gravel or crusher run 4-inches thick minimum placed directly beneath the proposed mat. The blanket shall extend a minimum of 12 inches beyond the extremities of the mat.

2. For subgrade preparation at structures and structural fill, the foundation material shall be select fillwhere specifically specified on Drawings, otherwise, screened gravel shall be used.

3. For ground under drains, pipe bedding, and drainage layers beneath structures the coarse aggregate shall meet the requirements of aggregate standard Size No. 57 or No. 67, as defined by VDOT Road and Bridge Specifications.

3.02 SELECT SAND

A. Design/Builder shall install select sand in accordance with the VDOT Road and Bridge Specifications and as shown on the Drawings and indicated in the Contract Documents.

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SECTION 02214

FLOWABLE FILL

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The Contractor shall furnish all labor, equipment, materials and services, including pumping equipment and application, necessary for the manufacture, transportation and placement of all cementitious flowable fill as shown on the Contract Drawings or as ordered by the Engineer, except for the work specifically included under other items.

1.02 RELATED WORK

A. Division 3 - Concrete

1.03 SUBMISSIONS

A. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall submit the following:

1. Shop Drawings

2. Certifications of specification compliance for all sources of each material

3. Manufacturer's data on all admixtures

4. Mix design and trial mix test results

5. Aggregate gradation

1.04 QUALITY CONTROL

A. The Contractor shall engage the services of a testing laboratory, with the qualifications required by Section 03300 - Cast-In-Place Concrete and experienced in the design and testing of flowable fill materials and mixes, to perform material evaluation tests and to design mixes for flowable fill. A trial mix shall be performed to verify the flowable fill mix design. The trial mix shall also report slump, air content, yield, cement content, and dry unit weight per ASTM C143 and ASTM D6023.

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PART 2 – MATERIALS

2.01 CEMENTITIOUS FLOWABLE FILL

A. Flowable fill (controlled low strength material) shall be a uniform mixture of sand, Type II Portland cement, fly ash, admixtures and water. The mix design shall produce a flowable material with little or no bleed water, which produces a minimum compressive strength of 50 psi and maximum compressive strength of 100 psi at 56 days. The cured material shall be excavatable and have a maximum dry weight of 100 pounds per cubic foot. Slump of mix at the point of application shall be 7-inches to 10-inches.

B. Admixtures specifically designed for flowable fill shall be used to improve flowability, reduce unit weight, control strength development, reduce settlement and reduce bleed water. Admixtures shall be Rheocell-Rheofill by BASF Construction Chemicals; Darafill by Grace Construction Products; or approved equal. Cement and all other materials shall be as specified in Section 03300 - Cast-In-Place Concrete.

C. Fine Aggregate (Sand) shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the following limits:

Sieve Size	Percent Passing by Weight
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100*	2 to 10

*For manufactured sand, the percent passing the No. 100 Sieve may be increased up to 20%.

PART 3 – EXECUTION

3.01 PLACEMENT OF FLOWABLE FILL

A. Flowable fill shall be batched and premixed by an approved producer, dispensed from ready-mix trucks, and placed by approved methods and equipment.

B. Flowable fill shall be placed so as to completely fill the space to receive it with no trapped air pockets or other voids. Positive means of allowing the air to escape shall be provided where necessary and after approval of the Engineer. Where placed against, around and inside existing structures, lift heights shall be limited so as not to overload the structure. The Engineer shall approve lift heights and procedures. Specific procedures and methods shall be included in the Contractor's shop drawing submittals.

C. Where flowable fill is placed around piping and other elements subject to floating within the fill space, positive means shall be taken to provide temporary balancing loads to prevent uplift or fill lift heights shall be limited to prevent uplift.

D. Application of loads or placement of other fill materials or concrete on top of flowable fill shall not occur until the flowable fill surface is determined to be suitable for loading per ASTM D6024 subject to the approval of the Engineer.

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SECTION 02274

GEOTEXTILES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all Geotextiles, including all necessary and incidental items, as detailed or required for the Contractor to complete the installation in accordance with the Drawings and these Specifications.

B. For the location of each type of Geotextile see the Drawings and Details.

1.02 REFERENCES

A. AASHTO Standards

1. AASHTO M 288-06 (2011) Geotextile Specification for Highway Applications

1.03 SUBMITTALS

A. Prior to shipping to the site, the Contractor shall submit to the Engineer two copies of a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each type of Geotextile. The Supplier shall also submit three Geotextile samples of each product, 1-yard square each, seamed and unseamed as appropriate, with the mill certificate for each Geotextile type supplied. The mill certificate or affidavit shall attest that the Geotextile meets the chemical, physical and manufacturing requirements stated in the specifications. The samples shall be labeled with the manufacturer's lot number, machine direction, date of sampling, project number, specifications, manufacturer and product name.

B. The Engineer shall be furnished copies of the delivery tickets or other acceptable receipts as evidence for materials received that will be incorporated into construction.

PART 2 -- MATERIALS

2.01 MATERIALS

A. Filter Geotextile shall be a minimum 6-ounce per square yard (nominal) nonwoven needle punched synthetic fabric consisting of staple or continuous filament polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long-term exposure to chemicals or liquids with a pH range from 3 to 10. The Geotextiles shall have a minimum threshold water head of 0.25-inches in the "as received" condition.

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1. Filter Geotextile shall have a Survivability Class of Class 1, 2 or 3 in accordance with AASHTO M288, unless otherwise specified herein.

B. Cushion Geotextile shall be a minimum 16-ounce per square yard nonwoven needle punched synthetic fabric consisting of continuous filament or staple polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long-term exposure to chemicals or liquids with a pH range from 3 to 10.

1. Cushion Geotextile shall have a Survivability Class of Class 1 in accordance with AASHTO M288.

C. Type I Separator Geotextile shall be a minimum 8-ounce per square yard (nominal) nonwoven neddlepunched synthetic fabric consisting of staple or continuous filament polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long term exposure to chemicals or liquids with a pH range from 3 to 10.

1. Type I Separator Geotextile shall have a Survivability Class of Class 1 or 2 in accordance with AASHTO M288, unless otherwise specified herein.

D. Type II Separator Geotextile shall be a woven slit film or monofilament synthetic fabric consisting of polyester or polypropylene in a manner approved by the Engineer. Geotextile shall be treated to resist degradation due to exposure to ultraviolet light.

1. Type II Separator Geotextile shall have a Survivability Class of Class 1 in accordance with AASHTO M288, unless otherwise specified herein.

E. All Geotextiles shall conform to the properties listed using the test methods listed in Table 1. The Contractor shall be responsible for timely submittals of all confirmation test data for Geotextiles.

PART 3 -- EXECUTION

3.01 SHIPPING, HANDLING AND STORAGE

A. During all periods of shipment and storage, all Geotextiles shall be protected from direct sunlight, temperature greater than 140°F water, mud, dirt, dust, and debris.

B. To the extent possible, the Geotextile shall be maintained wrapped in heavy-duty protective covering until use. Geotextile delivered to the project site without protective covering shall be rejected. After the protective covering has been removed, the Geotextile shall not be left uncovered for longer than fourteen (14) days, under any circumstances.

C. Unloading and storage of Geotextiles shall be the responsibility of the Contractor.

D. Geotextiles that are damaged during shipping or storage shall be rejected and replaced at Contractor expense.

3.02 QUALITY ASSURANCE CONFORMANCE TESTING

A. At the option of the Engineer representative samples of Geotextiles shall be obtained and tested by the Engineer to assure that the material properties conform to these Specifications. Conformance testing shall be conducted by the Engineer and paid for by the Contractor.

B. Conformance testing shall be completed at a minimum frequency of one sample per 100,000 square feet of Geotextile delivered to the project site. Sampling and testing shall be as directed by the Engineer.

C. Conformance testing of the Geotextiles shall include but not be limited to the following properties:

1. Mass Per Unit Area (ASTM D5261)

2. Grab Tensile Strength (ASTM D4632)

3. Trapezoidal Tear (ASTM D4533)

4. Puncture Resistance (ASTM D6241)

D. The Engineer may add to, remove or revise the test methods used for determination of conformance properties to allow for use of improved methods.

E. All Geotextile conformance test data shall meet or exceed requirements outlined in Table 1 of these Specifications for the particular category of Geotextile prior to installation. Any materials that do not conform to these requirements shall be retested or rejected at the direction of the Engineer.

F. Each roll of Geotextile will be visually inspected by the Engineer or his representative. The Engineer reserves the right to sample and test at any time and reject, if necessary, any material based on visual inspection or verification tests.

G. A Geotextile that is rejected shall be removed from the project site and replaced at the Contractor's expense. Sampling and conformance testing of the Geotextile supplied as replacement for rejected material shall be performed by the Engineer at Contractor's expense.

3.03 INSTALLATION

A. Geotextiles shall be placed to the lines and grades shown on the Drawings. At the time of installation, the Geotextile shall be rejected by the Engineer if it has defects, rips, holes, flaws, evidence of deterioration, or other damage.

B. It is the intent of these Specifications that Geotextiles used to protect natural drainage media be placed the same day as the drainage media to prevent soil, sediment or windblown soils to contact the drainage media.

C. The Geotextiles shall be placed smooth and free of excessive wrinkles. Geotextiles shall conform to and be in contact with the approved subgrade.

D. When the Geotextiles are placed on slopes, the upslope fabric portion shall be lapped such that it is the upper or exposed Geotextile.

E. Geotextiles shall be temporarily secured in a manner accepted by the Engineer prior to placement of overlying materials.

F. In the absence of specific requirements shown on the Drawings, the following shall be used for overlaps of adjacent rolls of Geotextile:

GEOTEXTILE TYPE/ APPLICATION	OVERLAP OF ADJACENT ROLLS[1] (INCHES)	TRANSVERSE END OVERLAP (INCHES)
Filter Geotextile	6 min	12 min
Cushion Geotextile	12 min	12 min
Separator-Roadway Applications	12 min	24 min
Separator-Slope Protection	18 min	24 min
Separator Geotextile	12 min	18 min

[1] Overlaps may be reduced if adjacent panels are sewn or heat bonded where approved by the Engineer.

G. Any Geotextile that is torn or punctured shall be repaired or replaced as directed by the Engineer by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of Geotextile placed over the failed areas and shall overlap the existing Geotextile a minimum of 12-inches from any point of the rupture.

H. Any Geotextile that is subjected to excessive sediment buildup on its surface during construction shall be replaced by the Contractor prior to placement of overlying material.

TABLE 1 - MINIMUM REQUIRED GEOTEXTILE PROPERTIES*

GEOTEXTILE PROPERTY	FILTER GEOTEXTILE	TYPE I SEPARATOR GEOTEXTILE	TYPE II SEPARATOR GEOTEXTILE
Geotextile Construction	Nonwoven Needlepunched	Nonwoven Neddlepunched	Woven
Ultraviolet Stability, (500 hrs.) ASTM D7238, Average % Strength Retention	70	70	70
Grab Tensile Strength (lbs.), ASTM D4632	120	160	315
Grab Tensile elongation (%) ASTM D4632	50	50	50
Trapezoid Tear Strength (lbs) ASTM D4533	50	60	120
Apparent Opening Size (AOS), (mm), ASTM D4751	0.212	0.212	0.425
Permittivity at 50 mm constant head (sec^{-1}), ASTM D4491	0.5	1.5	0.05
CBR Puncture Strength, ASTM D6241 (lb)	340	410	900

* **MINIMUM AVERAGE ROLL VALUE (MARV)**

(1) Warp Direction

(2) Fill Direction

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SECTION 02276

EROSION AND SEDIMENTATION CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. The Contractor shall employ a Responsible Land Disturber certified in the Commonwealth of Virginia who is responsible for implementing Best Management Practices (BMP's) to prevent and minimize erosion and resultant sedimentation in all cleared and grubbed areas during and after construction. This item covers the Work necessary for the installation of structure and measures for the prevention and control of soil erosion. The Contractor shall furnish all material, labor and equipment necessary for the proper installation, maintenance, inspection, monitoring, reporting, and removal (where applicable) of erosion prevention and control measures and to cause compliance with the General Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation for Discharges of Storm Water From Construction Activities (9 VAC 25-180), VPDES General Permit No. VAR10 under this Section, City of Winchester and Frederick County Virginia.

B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.

C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.

D. All Work under this Contract shall be done in conformance with and subject to the limitations of the Virginia Erosion and Sediment Control Handbook (VESCH) and the Virginia Erosion and Sediment Control Law, Regulations and Certification Regulations, as adopted in the Code of Virginia Title 10-1, Chapter 5, Article 4 and Sections 4VAC30-50 and 4VAC50-50 of the Virginia Administration Code.

E. The Contractor shall comply with all applicable minimum standards set in the Virginia Erosion and Sediment Control Handbook. The following excerpts from the VESCH Minimum Standards are particularly important:

1. Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant (undisturbed) for longer than 30 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

2. A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered

established until a ground cover is achieved that, in the opinion of the local program administrator or his designated agent, is uniform, mature enough to survive and will inhibit erosion.

3. Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation.

4. All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the local program administrator. Trapped sediment and the disturbed soil areas resulting from the deposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

F. Due to the nature of the Work required by this Contract, it is anticipated that the location and nature of the erosion and sedimentation control devices will be adjusted on several occasions to reflect the current phase of construction. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation. The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from constructed areas. All deviations from the erosion and sedimentation control provisions shown on the Drawings shall have the prior acceptance of the Engineer.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02100 – Clearing, Grubbing, and Site Preparation

B. Section 02200 – Earthwork

C. Section 02910 – Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all Work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. Code of Virginia, Title 10.1, Chapter 5, Article 4

2. Virginia Erosion and Sediment Control Handbook (VESCH), latest edition.

3. General Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation for Discharges of Storm Water from Construction Activities (9 VAC 25-180) and VPDES General Permit No. VAR10.

4. Erosion and Sediment Control Plan as required by the VPDES Permit.

5. Maintenance and Inspection Procedures as required by the VPDES Permit.

6. Frederick County Virginia Stormwater/Erosion Sediment Control Ordinance.

7. City of Winchester Virginia Stormwater Management and Water Quality Ordinance.

B. See Specification Section 01090 - Reference Standards.

1.04 REGULATORY COMPLIANCE

A. Land disturbance activities are not authorized to begin until after all required erosion and sediment control permits are obtained from the United States, Commonwealth of Virginia, and the City of Winchester and Frederick County. Contractor is the Co-Primary Permittee and Operator under the provisions of the VPDES Permit. As such, Contractor will be required to sign certain certifications as described in the VPDES Permit. Contractor shall comply with requirements specified in the Contract Documents or by the Engineer. Contractor shall also comply with all other laws, rules, regulations, ordinances and requirements concerning soil erosion and sediment control established in the United States, the Commonwealth of Virginia, and the City of Winchester and Frederick County. The following documents and the documents referenced therein define the regulatory requirements for this Section 02276.

1. VPDES PERMIT: The Virginia Pollution Discharge Elimination System (VPDES) General Permit (VAR 10) for Discharges of Storm Water from Construction Activity governs land disturbance or construction activities of one (1) acre or more. On applicable sites, Contractor is responsible for complying with terms and conditions of this permit.

2. Manual for Erosion and Sediment Control: Contractor shall follow Practices and Standards of the Virginia Erosion and Sediment Control Handbook (VESCH), Third Edition, or latest.

3. Storm Water Pollution Prevention Plan: The Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) and shall follow the practices described in the SWPPP.

1.05 SUBMITTALS

A. Prior to the start of the Work, the Contractor shall prepare and submit a plan for applying the temporary and permanent erosion and siltation control measures as shown on the Owner's approved Erosion and Sediment Control Plan. Construction Work shall not commence until the schedule of Work and the methods of operations have been reviewed and approved.

B. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.

3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

1.06 EROSION AND SEDIMENTATION CONTROL DEVICES

A. The following erosion and sedimentation control devices shall be incorporated into the Work. Other devices, as necessary and acceptable to the Engineer shall be installed as required.

1. Silt Fence shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Silt fence shall not be installed across streams, ditches or waterways. Silt Fence shall be designed, installed and maintained in accordance with requirements of Section 3.05 of the VESCH.

2. Block and Gravel Drop Inlet Sediment Filters shall be constructed at the locations shown on the drawings, and at other locations indicated by the Engineer. Dimensions shall be as shown on the Drawings. Block and Gravel Drop Inlet Sediment Filters shall be designed, installed and maintained in accordance with the requirements of Section 3.07 of the VESCH.

3. Temporary and Permanent Stormwater Conveyance Channels shall be installed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Channels and Channel Linings shall be designed, installed and maintained in accordance with the requirements of Sections 3.17 and 3.36 of the VESCH.

5. Temporary Construction Entrances shall be located at points where vehicles enter and leave a construction site and at other locations indicated by the Engineer. Temporary Construction Entrances shall be designed, installed and maintained in accordance with the requirements of Section 3.02 of the VESCH.

6. Block and Gravel Curb Inlet Sediment Filters shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Gravel Curb Inlet Sediment Filters shall be designed, installed and maintained in accordance with the requirements of Section 3.07 of the VESCH.

7. Culvert Inlet Protection shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Culvert Inlet Protection shall be designed, installed and maintained in accordance with the requirements of Section 3.08 of the VESCH.

1.07 GUARANTEE

A. All restoration and revegetation Work shall be subject to the correction period specified in the Contract Documents.

PART 2 -- MATERIALS

2.01 MATERIALS

A. Materials for use in erosion and sedimentation control devices shall be in accordance with the Virginia Erosion and Sediment Control Handbook.

2.03 SILT FENCE

A. Silt Fence shall be installed and maintained in accordance with the Maintenance paragraph, and Section 3.05 of the VESCH, to the satisfaction of the Engineer until the site has been stabilized. The cost of Silt Fence shall include the fabric, posts, wire fabric, excavation and all maintenance and restoration activities required.

B. Silt Fence shall be a woven geotextile filter fabric made specifically for sediment control. Filter fabric shall not rot when buried and shall resist attack from soil chemicals, alkalies and acids in the pH range from 2 to 13 and shall resist damage due to prolonged ultraviolet exposure. Filter fabric shall be Type FX-11, as manufactured by Carthage Mills, Type 910SC, as manufactured by Synthetic Industries, Inc., Amoco 2130 as manufactured by Amoco Fabrics & Fibers Co.

C. Filter fabric for the silt fence shall have the following minimum properties:

	Value	Test Method
Grab Tensile Strength	100 lbs	ASTM D 4632
Grab Elongation	15%	ASTM D 4632
Trapezoid Tear Strength	50 lbs	ASTM D 4533
Mullen Burst Strength	265 lbs	ASTM D 3786
Puncture Strength	58 lbs	ASTM D 4833
Retained Strength		
(500 hrs. accelerated		
UV exposure)	80%	ASTM D 4355
Filtration Efficiency	75%	VTM-51
Flow Rate	10/gal/min/ft.^{2}	ASTM D 4491
Height	36 inches	

D. Posts for silt fence shall be steel and shall have the following properties:

ASTM Designation:	ASTM A702
Length:	5-Feet Long (T-Type)
Weight:	1.25 lbs/foot (min.)
Area of Anchor Plate:	14 Sq. In.

Note: Five (T) Fasteners shall be furnished with each post.

E. Wire Fabric for the silt fence shall have the following properties:

Wire Fabric Designation:	832-12-10-12.5 Class 1
Designation:	ASTM A116
Width:	32"
Number of Line Wires:	8
Stay Wire Spacing:	12"
Line and Stay Wires:	12.5 Ga.
Top and Bottom Wires:	10 Ga.
Wire Coating:	ASTM Class 1 Zinc Coating

2.04 RIP RAP

A. The Contractor shall place rip rap as shown on the Drawings and as specified in Section 204 of the VDOT Road and Bridge Specifications. The stone for rip rap shall at a minimum be Class B and consist of field stone or rough unhewn quarry stone. The stone shall be sound, durable, and free from seams, cracks, or other structural defects.

2.05 STRAW WITH NET TEMPORARY SOIL STABILIZATION BLANKET (SSB)

A. The Contractor shall place straw with net temporary channel and slope SSB as shown on the Drawings. The blanket shall consist of clean wheat straw from agricultural crops made into a knitted straw blanket that is machine assembled. The straw shall be evenly distributed throughout the blanket. The blanket shall be covered with a photodegradable synthetic mesh attached to the straw with degradable thread.

B. The Contractor shall place the straw with net temporary channel and slope SSB where directed immediately after the channel or slope has been properly graded and prepared, fertilized, and seeded. The netting shall be on top with the straw in contact with the soil.

C. The Contractor will immediately repair or replaced section of straw with net temporary channel and slope SSB which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.

D. Straw with net SSB shall be North American Green S150 matting, American Excelsior Co., Curlex I, Contech SFB1, or equal with a minimum shear stress value of 1.50 lb./ft.^{2}

2.06 CURLED WOOD OR COCONUT FIBER TEMPORARY SOIL STABILIZATION BLANKET (SSB)

A. The Contractor shall place curled wood or coconut fiber channel and slope SSB in channels or on slopes as shown on the Drawings. The blanket shall consist of machine-produced mat of curled wood excelsior or coconut fiber with consistent thickness and the fibers evenly distributed over the entire area of the blanket. The top of the blanket

shall be covered with a biodegradable synthetic mesh. The mesh shall be attached to the curled wood excelsior or coconut fiber with photodegradable synthetic yarn.

B. The Contractor shall place the curled wood or coconut fiber channel and slope SSB where directed immediately after the ditch has been properly graded and prepared, fertilized, and seeded. The mesh shall be on top with the fibers in contact with the soil.

C. The Contractor will immediately repair or replace section of blanket which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.

D. Blanket shall be American Excelsior Curlex II, North American Green C125, Contech EFB4 or equal matting with a minimum shear stress value of 2.0 lb./ft.^{2}.

2.07 SYNTHETIC SOIL STABILIZATION MATTING (SSM)

A. The Design/Builder shall place synthetic channel and slope SSM in channel or on slope as shown on the Drawings. The mat shall consist of entangled nylon, polypropylene or polyester monofilaments mechanically joined at their intersections forming a three dimensional structure. The mat shall be crush-resistant, pliable, water permeable, and highly resistant to chemical and environmental degradation.

B. The Contractor shall place the synthetic SSM where directed immediately after the channel or slope has been properly graded and prepared.

C. After the SSM has been placed, the area shall be properly fertilized and seeded as specified allowing the fertilizer and seeds to drop through the net.

D. The Contractor will immediately repair or replace section of SSM which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.

E. Synthetic SSM shall be Enkamat 7020 as manufactured by Colband Geosynthetics, Synthetic Industries Landlock Erosion Mat TRM 1060, TH8 as manufactured by TC Mirifi, or equal matting with a minimum shear stress value of 5.0 lb./ft.^{2}.

2.08 TEMPORARY GRAVEL CONSTRUCTION ENTRANCES

A. Temporary gravel construction entrances shall be constructed as shown on the Drawings and as specified herein. Temporary gravel construction entrances shall be maintained in accordance with Part 3 of this Section, and Section 3.02 of the VESCH, to the satisfaction of the Engineer until the site has been stabilized. The cost of temporary gravel construction entrances shall include the gravel, truck wash racks and washwater, etc. and all maintenance activities required.

2.09 TEMPORARY SOIL STABILIZER

A. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as

"Enviroseal 2001" by Enviroseal Corporation, "Terra Control" by Quattro Environmental, Inc., or "CHEM-CRETE ECO-110" by International CHEM-CRETE Corporation, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on soil, forms a gelatinous crust.

2.10 CULVERT INLET PROTECTION

A. Culvert Inlet Protection shall be constructed as shown on the Drawings and as specified herein. The culvert inlet protection shall be constructed at the upstream end of all culverts as indicated and maintained in accordance with Part 3 of this Section, and Section 3.08 of the VESCH, to the satisfaction of the Engineer until the site has been stabilized. The cost of the culvert inlet protection shall include the excavation, grading, stone for erosion control, riprap, etc. and all maintenance activities required.

PART 3 -- EXECUTION

3.01 INSTALLATION AND MAINTENANCE

A. Erosion and sedimentation control devices shall be established prior to the clearing operations in a given area. Where such practice is not feasible, the erosion and sedimentation control device(s) shall be established immediately following completion of the clearing operation.

B. The Contractor shall furnish the labor, materials and equipment required for routine maintenance of all erosion and sedimentation control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device. Maintenance shall include but not be limited to 1) the removal and satisfactory disposal of trapped sediments from traps or silt barriers and 2) replacement of filter fabrics used for silt fences. Sediment removed from erosion and sedimentation control devices shall be disposed of in locations that will not result in off site sedimentation as acceptable to the Owner.

C. The Contractor shall provide temporary sedimentation traps at all locations shown on the Contract Drawings and for the settling of water pumped from the excavations or intercepted by drainage ditches for keeping water out of the excavations or to protect existing structures. The Contractor shall seed and mulch the earthen embankment with temporary or permanent vegetation immediately after installation. The Contractor shall remove trapped sediment from the basins when the design capacity has been reduced by 25% to maintain their effectiveness or as indicated by the Engineer. Sediment material removed from the basins shall be disposed by the Contractor in locations that will not result in off-site sedimentation as acceptable to the Owner.

1. Inspect temporary sediment traps at least once every 14 days and within 48 hours after each runoff producing rainfall event. Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one-forth the design volume of the trap. Place the sediment that is removed in a

designated disposal area and replace the contaminated part of the aggregate facing.

2. Check the structure for damage from erosion or piping. Periodically check the depth of the spillway to ensure it is a minimum of 1.0 ft. below the low point of the embankment. Immediately fill settlement of the embankment to slightly above design grade. Riprap displaced from the spillway must be replaced immediately.

3. After all sediment-producing areas have been permanently stabilized and permission has been obtained from the plan approving authority, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.

D. The Contractor shall provide temporary diversions at all locations noted on the Contract Drawings. All temporary diversions shall outlet at a temporary sediment trap or other appropriate structure.

1. Inspect temporary diversions at least once every 14 days and within 48 hours after each runoff producing rainfall event. Immediately remove sediment form the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized and permission has been obtained from the plan approving authority, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it.

E. Silt fence shall be erected as shown on the Drawings and specified herein. Silt fence shall be erected and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Replacement of the filter fabric, if required by the Engineer, will be at the Contractor's expense.

1. Inspect silt fence at least once every 14 days and within 48 hours after each runoff producing rainfall event. Make required repairs immediately.

2. Should the fabric of a silt fence collapse, tear, decompose or become in-effective, replace it promptly.

3. Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.

4. Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized. Removal of silt fence shall be permitted only with the prior approval of the Engineer, or the local governing agency.

F. Riprap shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a

properly graded, dense, neat layer of stone. The placed riprap shall have a minimum depth of 24 inches. Filter fabric shall be used under all riprap. The filter fabric must meet the requirements in Section 3.19 of the VESCH.

G. Riprap and stone for erosion control shall be dumped and placed in such manner that the larger rock fragments are uniformly distributed throughout the rock mass and the smaller fragments fill the voids between the larger fragments. Rearranging of individual stones by equipment or by hand shall only be required to the extent necessary to secure the results specified above, to protect structures from damage when rock material is placed against the structures or to protect the underlying Filter Fabric from damage during installation.

H. The Contractor shall provide Sit Fence Culvert Inlet Protection at all locations noted on the Contract Drawings.

1. Inspect Silt Fence Culvert Inlet Protection at least once every 14 days and within 48 hours after each runoff producing rainfall event. Remove sediment and restore the inlet protection to its original dimensions when the sediment has accumulated to one-half the design depth. Place the sediment that is removed in a designated disposal area and replace the contaminated part of the gravel facing, if used.

2. Check the structure for damage from tears, erosion, or piping. Filter fabric, posts, stone, or riprap displaced from the berm must be replaced immediately.

3. After all sediment-producing areas have been permanently stabilized and permission has been obtained from the plan approving authority, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.

I. Engineer may direct the Contractor to place Straw with Net, Curled Wood or Coconut Fiber SSB's and Synthetic SSM's in permanent channels or on slopes at other locations not shown on Drawings.

1. All temporary and permanent channel linings shall be unrolled in the ditch in the direction of the flow of water. Temporary and permanent linings shall be installed in accordance with the requirements of Section 3.36 of the VESCH and per manufacturer's specifications.

2. During the establishment period, check grass, SSB and SSM-lined channels at least once every 14 days and within 48 hours after each runoff producing rainfall event. For grass-lined channel once grass is established, check periodically and after every runoff producing rainfall event. Immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping and scour holes. Give special attention to the outlet and inlet sections and other points where concentrated flow enters. Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times.

J. The Contractor shall provide temporary construction entrances at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.

1. Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site. This may require periodic topdressing with VDOT #1 course aggregate. Inspect each construction entrance at least once every 14 days and within 48 hours after each runoff producing rainfall event and clean out as necessary. Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.

2. Contractor shall provide wash rack and wash water for temporary construction entrances. The roadway under the temporary construction entrance shall be graded to drain into temporary sediment traps until construction activities cease and site around temporary construction entrance has been permanently stabilized.

K. Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant (undisturbed) for longer than 30 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year. Preparation of areas for permanent stabilization shall be performed in accordance with Section 2.32 of the VESCH.

1. Reseed and mulch temporary seeding areas where seedling emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.

2. Generally, a stand of vegetation cannot be determined to be fully established until soil cover has been maintained for one full year from planting. Inspect seeded areas for failure and make necessary repairs and reseedings within the same season, if possible.

3. Reseeding – If a stand has inadequate cover, re-evaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand after seedbed preparation or over-seed the stand. Consider seeding temporary, annual species if the time of year is not appropriate for permanent seeding.

4. If vegetation fails to grow, soil must be tested to determine if acidity or nutrient imbalance is responsible.

5. Fertilization – On the typical disturbed site, full establishment usually requires refertilization in the second growing season. Fine turf requires annual maintenance fertilization. Use soil tests if possible or follow the guidelines given for the specific seeding mixture.

L. Additional Requirements

1. All storm sewer piping shall be blocked at the end of every Working day until the inlet is constructed above grade.

2. All streets around the construction area shall be scraped as necessary to prevent accumulation of dirt and debris.

3. The Contractor shall provide adequate means to prevent sediment from entering storm drains, curb inlets (curb inlet filter box), ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of trench or other excavation to prevent sedimentation of offsite areas. In areas where a natural buffer area exists between the Work area and the closest stream or water course, this area shall not be disturbed.

4. The Engineer may direct the Contractor to place additional sediment and erosion control devices at other locations not shown on the Drawings.

5. The Contractor shall monitor and take precautions to control dust, including, but not limited to, use of water or chemical dust palliative, limiting the number of vehicles allowed on site, minimizing the operating speed of all vehicles.

3.02 INSPECTIONS AND MAINTENANCE

A. The Contractor shall be responsible for the implementation of the Maintenance and Inspection Procedures as written by the Engineer. The implementation must comply with guidelines as set forth in General Virginia Pollutant Discharge Elimination System Permit Regulation for Discharges of Storm Water from Construction Activities (9 VAC 25-180) and VPDES General Permit No. VAR10.

B. The Contractor shall designate a Qualified Person to perform inspections required by this Section 02276. The following areas are to be inspected and maintenance performed, if needed, at least once every 14 calendar days and within 48 hours of the end of runoff producing storm event.

1. Disturbed areas of the construction site that have not undergone final stabilization

2. Erosion and sediment control structures

3. All locations where vehicles enter or exit the site

4. Material storage and construction laydown areas that are exposed to precipitation and have not been finally stabilized

C. When a Storm Water Pollution Prevention Plan (SWPPP) is provided in the Contract Documents, the Qualified Person shall follow the practices inspection and maintenance requirements described in the SWPPP. (See the Appendix for the SWPPP, if applicable). All appropriate records required by the SWPPP shall be maintained on site.

D. Immediate action will be taken to correct deficiencies to BMP's. The State reserves the

right to stop all construction activities not related to maintaining BMP's until such deficiencies are repaired.

E. In areas that have been finally stabilized, inspections and, if necessary, maintenance by Contractor will occur at least once per month for the duration of the contract or project, whichever is longer.

F. During inspections the following will be observed and appropriate maintenance procedures taken:

1. The conformance to specifications and current condition of all erosion and sediment control structures.

2. The effectiveness and operational success of all erosion and sediment control measures.

3. The presence of sediments or other pollutants in storm water runoff at all runoff discharge points.

4. If reasonably accessible, the presence of sediments or other pollutants in receiving Waters.

5. Evidence of off-site tracking at all locations where vehicles enter or exit the site.

G. An inspection checklist is included in the SWPPP. This checklist must be completed during each inspection, dated, and signed by the Qualified Person conducting the inspection. Completed inspection checklist shall be kept on-site with the Contract Documents and submitted to the Engineer on a monthly basis. The Contractor will repair deficiencies within 24 hours of inspection.

3.03 REMOVAL OF TEMPORARY SEDIMENT CONTROL STRUCTURES

A. At such time that temporary erosion and control structures are no longer required under this item, the Contractor shall notify the Engineer and the City of Winchester and Frederick County of its intent and schedule for the removal of the temporary structures and obtain the Engineer's approval in writing prior to removal. Once the Contractor has received such written approval from the Engineer, the Contractor shall remove, as approved, the temporary structures and all sediments accumulated at the removed structure shall be returned upgrade. In areas where temporary control structures are removed, the site shall be left in a condition that will restore original drainage. Such areas shall be evenly graded and seeded as specified in Section 02910, Final Grading and Landscaping.

3.04 NOTICE OF TERMINATION

A. When all construction activities have ceased, final stabilization has been implemented by the Contractor, and the site is in compliance with the VPDES permit, the Contractor, together with the Engineer shall submit a Notice of Termination.

- END OF SECTION -

SECTION 02500

SURFACE RESTORATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide all labor, equipment, and materials necessary for final grading, topsoil placement, and miscellaneous site work not included under other Sections but required to complete the work as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

B. Section 02276 - Erosion and Sedimentation Control

C. Section 02910 - Final Grading and Landscaping

PART 2 -- MATERIALS

2.01 TOPSOIL

A. Topsoil shall meet the requirements of Section 02200 – Earthwork.

PART 3 -- EXECUTION

3.01 FINAL GRADING

A. Following approval of rough grading the subgrade shall be prepared as follows:

1. For riprap, bare soil 24 inches below finish grade or as directed by Engineer.

2. For topsoil, scarify 2-inches deep at 4 inches below finish grade.

3.02 TOPSOIL PLACEMENT

A. Topsoil shall be placed over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped.

B. Topsoil shall be spread in place for lawn and road shoulder seed areas at a 4-inch consolidated depth and at a sufficient quantity for plant beds and backfill for shrubs and trees.

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C. Topsoil shall not be placed in a frozen or muddy condition.

D. Final surface shall be hand or mechanically raked to an even finished surface to finish grade as shown on Drawings.

E. All stones and roots over 4-inches and rubbish and other deleterious materials shall be removed and disposed of by Contractor.

- END OF SECTION -

SECTION 02510

PAVING AND SURFACING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, equipment and materials and perform all operations in connection with the construction of asphalt concrete pavement, asphalt concrete overlay, reinforced concrete pavement, gravel roads, concrete curb and gutter, repair and reconstruction of existing asphalt concrete pavement, repair of existing gravel roads, and pavement markings complete as specified herein and as detailed on the Drawings.

B. All new roads including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses and types as shown on the Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt and/or gravel, depending upon the material encountered, unless otherwise indicated.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1, Division 2 and Division 3 of these Specifications.

1.03 RELATED SECTIONS

A. Section 02200 - Earthwork

B. Section 03300 - Cast-In-Place Concrete

1.04 STANDARD SPECIFICATIONS

A. Except as otherwise provided in the Specifications or on the plans, all work shall be in accordance with the Virginia Department of Transportation Standard Specifications for Roads and Structures, 2016 except that any reference to "VDOT", "Department" or "Unit" shall mean the "Owner". When reference to these Specifications is intended, the description will be VDOT Section or VDOT Specifications.

B. Except with the approval of the Engineer, the placement of concrete or asphalt concrete surface paving shall be subject to the Seasonal and Weather Restrictions set forth in VDOT Specifications.

PART 2 -- MATERIALS

2.01 SELECT FILL

A. The Contractor shall place select fill as necessary to complete the embankments, shoulders, subgrade foundation and replacement for removed unsuitable material in accordance with VDOT Section 303, and Section 02200 - Earthwork.

2.02 GRAVEL

A. All work, including materials, associated with gravel shall be in accordance with VDOT Section 207, Select Material, except that Articles 207.07shall be deleted.

2.03 AGGREGATE STABILIZATION

A. All work, including materials, associated with Aggregate Stabilization shall be in accordance with VDOT Sections 306 and 307, Lime and Hydraulic Cement Stabilization, except that Articles 306.04 and 307.06, shall be deleted.

2.04 AGGREGATE BASE MATERIAL

A. All work, including materials, associated with Aggregate Base Material shall be in accordance with VDOT Section 208, Aggregate Base Material, except that Article 208.08 shall be deleted. Type 21-A or Type 21-B aggregate will be acceptable for this project.

2.05 ASPHALT BINDER FOR PLANT MIX

A. All work, including materials, associated with asphalt binder shall be in accordance with Section 210, Asphalt Materials, Grade PG 64H-22, of the VDOT Standard Specifications for Roads and Structures, except Article 210.09 shall be deleted.

2.06 ASPHALT PAVEMENTS

A. All work, including materials, associated with asphalt pavement shall be in accordance with Section 211, Asphalt Concrete, of the VDOT Standard Specifications for Roads and Structures. Surface Course shall be Superpave S-9.5B, Intermediate Course shall be Superpave I-19.0B, and Base Course shall be Superpave B-25.0C. Asphalt pavement mix designs shall be in accordance with TABLE II-14 of the VDOT Specifications.

B. The job mix formulas (JMF) shall be delivered to the Engineer at least two (2) weeks prior to beginning paving operations. The JMF submitted for asphalt concrete pavement shall be dated to within 12 months of asphalt placement.

2.07 RIGID PORTLAND CEMENT CONCRETE PAVEMENT

A. All work, including materials associated with rigid concrete pavement shall be in accordance with Section 03300, Cast-In-Place Concrete and Section 217 of the VDOT Standard Specifications for Roads and Structures . Class A concrete shall be used.

Placement shall be in accordance with Section 03300 and VDOT Section 316, Hydraulic Cement Concrete Pavement and Section 710, Concrete Pavement, except that Article 316.06 shall be deleted.

2.08 RIGID CONCRETE PAVEMENT REINFORCING

A. Reinforcing, if specified, shall be as shown on the Structural Drawings and as specified under Section 03200 - Reinforcing Steel.

2.09 CONCRETE CURB AND GUTTERS

A. Concrete shall be Class B in accordance with the requirements of Section 03300 - Cast-In-Place Concrete, except that concrete shall be air-entrained to provide an air content of 6% ± 1.5%.

B. Premolded expansion joint filler for expansion joints shall conform to ASTM D 1751 and shall be 1/2-inch thick, minimum.

2.10 ASPHALT TACK COAT

A. All work, including materials, associated with asphalt tack coat shall be in accordance with Section 310 - Tack Coat, of the VDOT Standard Specifications for Roads and Structures, except that Article 310.04 shall be deleted.

PART 3 -- EXECUTION

3.01 EMBANKMENT

A. The embankment shall be constructed in accordance with Section 02200 - Earthwork.

3.02 SUBGRADE

A. The subgrade, where shown on the Drawings, shall be aggregate stabilized by the addition and mixing of coarse aggregate with the top 3-inches of subgrade in accordance with VDOT Section 305. Aggregate stabilization shall be applied to the subgrade at a rate of 300-pounds per square yard. Following the application of stabilizer aggregate, the subgrade shall be formed true to crown and grade and shall be compacted with a minimum of four (4) passes of a 15-ton vibratory roller to conform to the maximum densities determined by AASHTO T99 Standard Specifications.

3.03 AGGREGATE BASE MATERIAL

A. The finished base course of all paving shall be Aggregate Base Material and shall be of the thickness shown on the Drawings, formed true to crown and grade. Gravel roads, including repair to existing gravel roads shall be Aggregate Base Material and shall be of the thicknesses shown on the Drawings, formed true to crown and grade. No fill material except new Aggregate Base Material shall be placed on top of existing gravel.

3.04 ASPHALT BASE COURSE (OR INTERMEDIATE COURSE)

A. Asphalt Concrete Base (or Intermediate) Course shall be placed in accordance with VDOT Standard Specifications for Roads and Structures Section 315, Asphalt Concrete Placement. Asphalt Concrete Base (or Intermediate) Course shall be compacted in accordance with the VDOT Standard. Thicknesses shall be as shown on the Drawings.

3.05 ASPHALT CONCRETE SURFACE COURSE

A. Prior to placement of the asphalt concrete surface course, the base/intermediate course shall be inspected for damage or defects and repaired to the satisfaction of the Engineer. The surface of the base/intermediate course shall be approved by the Engineer.

B. The asphalt tack coat shall be applied to the surface of the approved base/binder course as described in VDOT Section 310. Equipment for applying the tack coat shall be power-oriented pressure spraying or distributing equipment suitable for the materials to be applied and approved by the Engineer.

C. The Asphalt Concrete Surface Course shall be placed and compacted on the base/intermediate course in layers not to exceed 2-inches and at the rate of 110-pounds per square yard per inch. Surface Course shall be compacted in accordance with VDOT Standard Specifications. Thicknesses shall be as shown on the Drawings.

3.06 ASPHALT CONCRETE PAVEMENT COMPACTION

A. Asphalt concrete pavement placement and compaction shall be performed as per VDOT Road and Bridge Specifications, Section 315.05 - Procedures.

B. Contractor shall provide Quality Control (QC) for proper asphalt concrete pavement placement and compaction using equipment in good working order which has been properly calibrated at the start of each round of testing. Quality Assurance (QA) of paving operations will be performed by an independent third-party representative hired by Owner.

C. Immediately after the asphalt mixture has been spread, struck off and surface and edge irregularities adjusted, thoroughly and uniformly compact the pavement. Compact the mix to the required degree of compaction for the type of mixture being placed, as noted in Table III-3 of the VDOT Road and Bridge Standard Specifications, latest edition, and reproduced below:

TABLE III-3
DENSITY REQUIREMENTS

Superpave Mix Type	Minimum % Gmm (Maximum Specific Gravity
SM-9.5A, 12.5A	92.5
SM-9.5D, 12.5D	92.2
SM-9.5E, 12.5E	92.2
IM-19.0A, IM-19.0D, IM-19.0E	92.2

BM-25.0A, BM-25.0D	92.2

3.07 ASPHALT CONCRETE PAVEMENT PHASING

A. Contractor shall be responsible for phasing the placement of asphalt concrete pavement sections and courses to account for individual construction activities, the construction traffic volume, and vehicle loading expected throughout construction activities. The placement of asphalt concrete pavement shall also be phased so the aggregate base course, once installed, is not be exposed to freeze/thaw cycles.

3.08 RIGID PORTLAND CEMENT CONCRETE

A. The subgrade and base course beneath portland cement concrete pavement shall be prepared in accordance with the applicable Sections of these Specifications and referenced Standard Specifications.

B. The surface of the base shall be damp at the time the concrete is placed. The Contractor shall sprinkle the base when necessary to provide a damp surface. The Contractor shall satisfactorily correct all soft areas in the subgrade or base prior to placing concrete.

C. Hauling over the base course shall not be allowed except where specifically permitted by and in writing by the Engineer. The Engineer may allow equipment dumping concrete to operate on the base to the extent and under the conditions the Engineer deems necessary to facilitate placing and spreading the concrete.

D. Installation of the rigid concrete pavement shall be in accordance with the details shown on the Drawings and Division 3 - Concrete. The rigid concrete pavement shall cure a minimum of ten (10) calendar days and until the concrete has attained a minimum flexural strength of 550 psi as indicated by flexural strength testing. The Contractor shall coordinate and pay for all flexural strength testing with a minimum of four (4) 6-inch by 6-inch by 20-inch beams for every fifty (50) cubic yards of pavement concrete installed.

E. Transverse and longitudinal joints shall be spaced at intervals as shown on the Drawings and installed as per the requirements of VDOT Road and Bridge Specifications, Section 316.04 -Procedures. Transverse contraction joints shall be formed by an approved joint insert. Longitudinal joints shall be formed by allowing the paver to deposit the mixture adjacent to the joint to such depth that maximum compaction can be obtained along the joint. Pinch the joint by rolling immediately behind the paver. Expansion joints shall be placed when the pavement abuts a structure using 1-inch expansion joint material (filler) and sealant as specified herein.

3.09 ASPHALT CONCRETE DENSITY ACCEPTANCE

A. The Engineer will evaluate the asphalt pavement for density acceptance after the asphalt mix has been placed and compacted using the Contractor's QC test results, the Owner’s QA test results (including verification samples) and by observation of the

Contractor's density QC process conducted in accordance with VDOT Road and Bridge Specifications, Section 315.05.

B. Minimum density requirements for all mixes will be as specified in Table III-3. Density acceptance will be as provided herein. Core sample shall be obtained and tested by the Owner's representative at the same frequency and location as the Contractor's QC testing, if possible, and densities will be determined by use of the requirements as outlined in VDOT Road and Bridge Specifications 315.05.

C. A failing lot for density acceptance purposes is defined as a lot for which the average of all test sections, and portions thereof, fails to meet the minimum specification requirement. A lot will consist of one day's production of a given JMF, for each layer of asphalt concrete placed. If additional density sampling and testing, beyond the minimum requirement, is performed and additional test sections are thereby created, then all test results shall be included in the lot average.

D. Any lot or portion of a lot deemed obviously unacceptable by the Owner or Engineer will be rejected for use in the work. If the Engineer determines that a given lot of mix does not meet the minimum specification requirements, but the work is reasonably acceptable, the lot will be accepted at a reduced pay factor in accordance with Table III-4 of the VDOT Road and Bridge Specifications. The reduced pay factor will apply only to the contractor's schedule of values.

TABLE III-4
PAYMENT SCHEDULE FOR LOT DENSITIES

% of Target Control Strip Density	% of Payment
Greater than 102.0	95
98.0 to 102.0	100
97.0 to less than 98.0	95
96.0 to less than 97.0	90
Less than 96.0	75

3.10 CONCRETE CURB AND GUTTER

A. The expansion joint filler for concrete curb and gutters shall be cut to conform with the cross section of the curb. Expansion joints shall be spaced at intervals of not more than 25-feet. Formed control joints shall be installed at intervals not exceeding 10 feet. Depth of joint shall be 1/3 the thickness. Curved forms shall be used where radii are indicated; straight segments shall not be permitted. Upon removal of the forms, exposed curb faces shall be immediately rubbed down to a smooth and uniform surface. No plastering shall be permitted.

3.11 UNDERGROUND UTILITY LINES

A. Where an underground utility line is beneath the new roadway, the backfilling shall be carried out with special care, and the final consolidation shall be accomplished by a

vibratory roller. Construction of the roadway over the trench shall be deferred as long as practicable.

3.12 JUNCTION WITH OTHER PAVING

A. Where new asphalt concrete pavement abuts existing asphalt concrete pavement, the existing pavement shall be cut back to insure obtaining the specified compaction of the new pavement courses and interlocking adjoining courses. Existing subbase courses shall be cut back from the subgrade level of the new pavement on a one-on-one slope into the existing pavement, and the asphalt courses of the existing pavement shall be removed for an additional 6-inches back from the slope. The edge of the existing asphalt courses shall be saw cut straight and true. The faces between new and existing asphalt courses shall receive an application of tack coat.

B. Where new rigid concrete pavement abuts existing rigid concrete or asphalt concrete paving, the existing paving shall be saw cut straight and true. An expansion joint of a 1/2-inch minimum thickness with filler material and sealant shall be placed between the new concrete pavement and the existing rigid concrete or asphalt concrete paving.

3.13 ASPHALT CONCRETE OVERLAY

A. Where asphalt concrete is proposed to be placed over an existing asphalt or rigid concrete surface, the surfaces shall be thoroughly cleaned by power brooming and a tack coat shall be applied in accordance with VDOT Section 310, Tack Coat, of the VDOT Standard Specifications for Roads and Structures, prior to installing the overlay. The overlay shall be applied in accordance with the Standard Details shown on the Drawings.

-END OF SECTION -

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SECTION 02604

UTILITY STRUCTURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, equipment, and tools required for the design, fabrication, delivery and installment of utility structures, storm drain pipe, and appurtenances in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork

B. Section 03200 – Reinforcing Steel

C. Section 03250 – Concrete Accessories

D. Section 03300 – Cast-in-Place Concrete

E. Section 03400 – Precast Concrete

F. Section 05540 – Castings

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

2. ASTM C361-16 – Standard Specification for Reinforced Concrete Low-Head Pressure Pipe

3. ASTM C443-12 – Standard Specification for Joints in Concrete Pipe and Manholes, Using Rubber Gaskets

4. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections

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5. ASTM C857 – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

6. ASTM C990-09 – Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

7. ASTM C1619 – Standard Specification for Elastomeric Seals for Joining Concrete Structures

8. ASTM C1628-17 – Standard Specification for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets

1.04 SUBMITTALS

A. Submit samples and/or Shop Drawings in accordance with Section 01300 - Submittals.

B. In addition to items listed in Section 03400 - Precast Concrete, Shop Drawings shall include, but not be limited to:

1. Complete layout and installation Drawings and schedules with clearly marked dimensions.

2. Material certificates on all piping materials.

3. Structural design calculations for manhole and other below grade utility structures sealed by a Professional Engineer registered in the Commonwealth of Virginia. Design calculations for precast manholes and vaults shall include confirmation structures adequately resist flotation when completely empty and subjected to groundwater to the full height of structure.

4. Results of leakage test.

PART 2 -- PRODUCTS

2.01 PRECAST MANHOLES, VAULTS, AND METER BOXES

A. Precast utility structures shall be furnished with waterstops, sleeves and openings as noted on the Drawings. Box out for wall pipes shall conform accurately to the sizes and elevations of the adjoining pipes. Precast utility structures shall be watertight and conform to the requirements of ASTM C 478 and ASTM C857 with the following modifications there to:

1. Materials shall conform to Section 03400 - Precast Concrete.

2. Manholes shall meet the following:

a. Manhole section shall have an internal diameter of 4'-0", unless noted otherwise.

b. Minimum manhole wall thicknesses shall be 5 inches for 4-foot and 5-foot diameter manholes, 6 inches for 6-foot diameter manholes and 7 inches for 7-foot diameter manholes.

c. Manholes and utility structures shall include ballast concrete and/or other means necessary to insure manholes resist flotation when empty and subjected to groundwater full height of structure.

d. Precast manholes and utility structures shall be as manufactured by Encore Precast, LLC, Forterra Pipe and Precast, or equal.

3. The date and name of manufacturer shall be marked inside each precast section.

4. No more than two lift holes may be cast or drilled in each section.

5. Dimensions shall be as shown on the Drawings.

6. Covers and frames shall be as specified in Section 2.13.

7. Mechanical Details such as piping, electrical, and other details shall be as shown on the Drawings.

B. Joints between manhole and utility structures riser sections and at base slabs shall be groove type.

2.02 BRICK

A. Brick shall be sound, hard-burned common brick conforming to ASTM C32, Grade MS.

2.03 MORTAR

A. Mortar shall conform to Section 04100 - Mortar and Masonry Grout.

2.04 CONCRETE

A. Concrete shall conform to Section 03300 - Cast-in-Place Concrete.

2.05 REINFORCING

A. Reinforcing shall conform to Section 03200 - Reinforcing Steel.

2.06 PRECAST CONCRETE

A. Precast concrete shall conform to Section 03400 - Precast Concrete.

2.07 CONCRETE BLOCK

A. Concrete block shall be solid, rectangular concrete masonry units conforming to ASTM C139.

2.08 CASTINGS

A. Castings shall conform to Section 05540 - Castings. Casting shall be of the type and size indicated on the Drawings.

2.09 MANHOLE STEPS

A. Steps shall be constructed of Grade 60 steel reinforcing rod (min. 1/2-inch) and completely encapsulated with a wear resistant and chemical resistant rubber.

B. Each step shall have a minimum vertical load resistance of 800 pounds and a minimum pull-out resistance of 400 pounds.

C. The steps shall have 11-inch minimum tread width and shall be placed at 16-inches on center, as shown on the Drawings.

D. Steps shall be cast in place with the concrete.

E. Steps shall only be installed as shown on the Drawings or required in the Specifications.

2.10 JOINT SEALANT FOR STRUCTURES

A. Joint sealant shall be a preformed flexible sealant conforming to the requirements of ASTM C-443-12 (2017) and ASTM C990-09 (2014), paragraph 6.2, Butyl Rubber Sealant. Joint sealant shall be Pro-Stik Butyl Sealant by Press-Seal, Butyl-Nek Join Sealant by Henry CS-102 Butyl Rubber Sealant for all Precast Structures by ConSeal, or equal.

2.11 FLEXIBLE RUBBER SLEEVE

A. The spring set type shall have a stainless-steel interior power sleeve or expander and shall be the PSX assembly by Press-Seal Gasket Corporation, the Kor-N-Seal assembly by National Pollution Control Systems, or Lock Joint Flexible Manhole Sleeve by Interpace Corp.

B. The cast-in-place type shall conform to ASTM C923 and shall include stainless steel take up clamps.

C. Flexible seal assemblies shall permit at least an eight (8) degree deflection from the center line of the opening in any direction while maintaining a watertight connection.

2.12 RUBBER BLADDER

A. The rubber bladder seal shall conform to ASTM C923 suitable for pressure testing at 10 psi minimum, with a 3/8-inch minimum wall thickness.

B. The rubber bladder seal shall contain an environmentally safe, anti-bacterial compound which turns into a high viscosity gel when in contact with pressurized water.

C. The rubber bladder seal shall be NPC Contour Seal by Kor-N-Seal, or equal.

2.13 COVERS AND FRAMES

A. Covers and frames shall comply with Section 05540 - Castings and shall be provided by the utility structure manufacturer.

B. Manhole covers and frames shall meet the following requirements:

1. Locate so that there is ready access to the manhole steps

2. Clear opening shall be a minimum of 22 inches, unless otherwise indicated on the Drawings.

3. Watertight manhole frames and covers shall be suitable for 20 psi internal pressure and shall be Neenah Model R-1915, Type P or L or equal cast in place.

4. Non-watertight manhole covers shall be perforated and shall be Neenah Model R-1668, or equal.

5. Storm drain grated inlet frames and grates shall be Neenah R-1878-B7G, East Jordan Iron Works V5660, or equal.

6. Curb inlet frames and grates shall be Neenah R-3067, East Jordan Iron Works EJ 7030, or equal, and shall include frame, grate, and hood.

C. Vault covers shall have lifting handles and shall be bolted with stainless steel bolts complying with Section 05050 - Metal Fastening.

D. Frames and covers shall be identical throughout the Contract.

2.14 GRATES

A. Grates shall comply with Section 05540 - Castings.

2.15 CONCRETE BALLAST

A. Concrete ballast shall be Class B concrete in conformance with Section 03300 - Cast-in-Place Concrete. Ballast shall be provided as necessary to insure manhole resists flotation when empty and subjected to full height groundwater conditions.

2.16 FLEXIBLE JOINT SEALER

A. Flexible joint sealer shall be a rubber ring waterstop as manufactured by Fernco Joint Sealer Co., or equal.

2.17 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to Section 03250 - Concrete Accessories.

2.18 DUCTILE IRON PIPE (DIP) – ROOF DRAINS

A. Pipe

1. Shall be centrifugally cast in metal molds or sand lined molds in accordance with ANSI A21.51 (AWWA C151) of grade 70-50-05 ductile iron. The above standard covers ductile iron pipe with nominal pipe sizes from three (3) inches up to and including fifty-four (54) inches in diameter.

2. Shall have a rated working pressure of 150 psi.

3. Shall be a minimum PC 150.

B. Fittings

1. Shall be manufactured in accordance with ANSI A21.10 (AWWA C110).

2. Shall be manufactured of grade 70 - 50 - 05 ductile iron.

3. Shall have a rated working pressure of 250 psi.

4. Grey iron fittings which conform to the specifications contained herein may be used with ductile iron pipe providing the piping systems minimum working pressure is met or exceeded, and only where ductile iron fittings are not manufactured for a specific fitting.

C. Coatings and Linings for Pipe and Fittings

1. The standard asphaltic coating shall be applied to the exterior wall of the pipe and fittings in accordance with ANSI A21.51 (AWWA C151).

2. The pipe and fittings shall be cement mortar lined to twice the standard thickness in accordance with ANSI A21.4 (AWWA C104) except as specified in the pipe schedule. A seal coat of asphaltic material shall be applied to the mortar lining.

D. Joints

1. Joints shall be push on type in accordance with ANSI A21.11 (AWWA CIII).

PART 3 -- EXECUTION

3.01 DESIGN CRITERIA

A. Minimum structural design loading for underground precast concrete vaults shall be as indicated in ASTM C857, unless otherwise noted herein. Precast items subjected to vehicular traffic shall be designed for H-20 traffic loading. Other precast items shall be designed for a vertical live load of 300 psf.

B. Walls of precast items shall be designed for a vertical surcharge of 100 psf.

C. Precast manholes and vaults shall be designed to resist flotation when totally empty and subjected to groundwater full height of the manhole/vault.

3.02 FABRICATION AND CASTING

A. Fabrication and casting shall conform to Section 03400 - Precast Concrete, and to Section 03300 - Cast-in-Place Concrete.

B. All base sections designated to receive concrete ballast and all electrical manholes shall extend monolithically a minimum of 6 inches beyond the outside face of the wall for the entire periphery. All other utility structures shall have a standard base.

C. Utility structures built around existing pipe shall have a cast-in-place base slab.

3.03 HANDLING, TRANSPORTING, AND STORING

A. Handling, transporting and storing of precast items shall comply with Section 03400 - Precast Concrete.

3.04 STRUCTURE INSTALLATION

A. Installation shall conform with Section 03400 - Precast Concrete and with the manufacturer's recommendations or to Section 03300 - Cast-in-Place Concrete.

B. Frames and covers or grates shall be set so that tops are at elevations indicated on the Drawings or flush with finished grade where no elevation is indicated.

C. Joints between riser sections shall be sealed with joint sealant.

D. All openings in utility structures shall have flexible rubber sleeves sized to fit the connecting pipe and installed to provide watertight joints in accordance with the manufacturer's recommendations. The interior of the sleeve shall be filled with Class B concrete.

E. Openings that are too large for flexible rubber sleeves shall utilize rubber bladder seals which are expanded by water injected using a pressure pump.

F. All units shall be installed plumb and level.

G. All lift holes and joints shall be filled with non-shrink grout conforming to Section 03600 - grout inside and out.

H. The manhole frames shall be set to their required elevations either with grade rings or with two or three courses of brick masonry laid around the top of the upper wall section. Such brick work shall be given a 1-inch mortar coat on the inside and out.

I. Concrete ballast shall be placed so that it bears directly on the utility structure base against the outer wall monolithically encircling the structure for the full height indicated on the Drawings. Additional ballast may be required where the depth or elevation of the structure varies from the Drawings.

J. Brick or Concrete Block

Brick or concrete block shall be laid with broken joints and all horizontal and vertical joints filled with cement-sand mortar. Outside of walls shall be plastered with a minimum 1-inch thick coat of cement-sand mortar troweled smooth.

K. Connection to Existing Pipe

1. Verify the diameter and invert elevation of existing pipe to be connected to new utility structures prior to beginning work on the structures.

2. Provide adequate protection to prevent damage to the existing pipe.

3. Provide adequate means for plugging and/or transferring the existing flow in the pipe to allow for the construction of inverts and grouting.

4. Cut off the existing pipe sufficiently for connection to the new structure and remove.

5. Thoroughly clean all foreign matter and coat the pipe surface with epoxy adhesive where the pipe joins the new structure.

6. Install a flexible joint sealer around the pipe.

7. Grout inside and outside of wall penetration with nonshrink grout.

L. Backfill structures in accordance with Section 02200 - Earthwork.

M. Clean all structures of any accumulation of silt, debris, or foreign matter and keep clean until final acceptance of the work.

N. Excavation shall conform to Section 02200 - Earthwork.

O. Structure bases shall bear on a minimum of 8 inches of compacted stone unless otherwise indicated on the Drawings.

P. Channel Inverts

1. Inverts shall be placed using Class B concrete with forms sufficient to provide a smooth half-round shape as shown on the Drawings. Manhole bases employing full depth precast inverts are acceptable.

2. Where the slope of the line does not change through a manhole, a constant slope shall be maintained in the invert. Where slope changes occur within a given manhole, the transition shall be smooth and shall occur at the approximate center of the manhole.

3. Inverts shown on the Drawings are taken at the center of the manhole unless otherwise noted.

3.05 ADJUSTMENTS TO EXISTING UTILITY STRUCTURES

A. Adjust structures as indicated on the Drawings using concrete or cast-iron adjustment rings by approved methods.

B. Clean covers and inlet castings of all foreign material and paint with one coat of coal tar epoxy.

3.06 ADJUSTING COLLARS AND FINAL ADJUSTMENTS

A. Adjusting collars shall be as shown on the Drawings. Final adjustments shall be made so that the manhole ring and cover will be smooth and flush with the finished grade of the adjacent surface, or as otherwise indicated on the Drawings for manholes shown above grade.

3.07 PIPE INSPECTION

A. Each length of pipe and fittings delivered to the property shall be inspected by the Contractor, in the presence of the Engineer, for flaws, cracks, dimensional tolerances and compliance with the referenced Standards. The Contractor shall provide the Engineer with suitable templates or calipers for checking pipe dimensions. Only lengths of pipe and fittings accepted by the Engineer and so marked may be installed in the work.

3.08 PIPE INSTALLATION

A. Trenching, bedding and backfilling shall be as specified in Section 02200 - Earthwork. Under no condition shall pipe be laid in water or when trench conditions or weather are unsuitable for such work.

B. All pipes and fittings shall be handled carefully in loading and unloading. They shall be lifted by hoists or lowered on skidways in such a manner as to avoid shock. Derricks, ropes or other suitable equipment shall be used for lowering the pipe into the trench. Pipe and fittings shall not be dropped or dumped.

C. Each pipe and fitting shall be inspected before it is lowered into the trench. The interior of the pipe and all joint surfaces shall be thoroughly cleaned and shall thereafter be maintained clean. The open ends of pipe shall be securely plugged whenever pipe laying

is not in progress.

D. Pipe and fittings shall be selected so that there will be as small a deviation as possible at the joints and so that inverts present a smooth surface. All joints shall be installed, made up and inspected in accordance with approved printed instructions of the manufacturer. Pipe and fittings which do not fit together to form a tight joint will be rejected.

E. Cutting of reinforced concrete pipe will be permitted only at connections to structures and be accomplished by abrasive saws. Cutting of other pipe materials shall be done only with mechanical cutters and in accordance with the manufacturer's recommendations.

F. Pipe shall be laid accurately to the lines and grades shown on the drawings or as directed by the Engineer.

G. If an adequate foundation for the pipe is not available at the desired depth, additional excavation shall be required, and the foundation brought to desired grade with suitable granular material.

H. Rock outcroppings, very soft soils such as muck, and other similar materials not providing proper foundation support shall be removed/replaced with suitable granular material.

I. Bedding material directly under the pipe invert shall be left in native condition and not compacted. Pipe shall be placed on the bedding, then backfilled under the pipe haunches before further backfill is placed.

J. Class I materials may be dumped around pipe. Voids shall be eliminated by knifing under and around the pipe or by other approved technique.

K. Inorganic silts, and gravelly, sandy, or silty clays, and other Class IV materials (not shown in Table 1) shall not be used for pipe backfill.

L. Any section of the pipe that is found defective in material, alignment, grade, joints, or otherwise, shall be satisfactorily corrected by the Contractor at no additional cost to the Owner.

3.09 PIPE TRENCH COMPACTION

A. General

1. Place and assure backfill and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.

2. In no case shall degree of compaction below “Minimum Compactions” specified be accepted.

3. Compaction Requirements: Unless noted otherwise on the Drawings or more stringently by other sections of these Specifications, comply with following trench compaction criteria:

TABLE 1 – - MINIMUM COMPACTIONS

LOCATION	SOIL TYPE	DENSITY
1. Compacted select backfill:		
All applicable areas	Cohesive soil	95 percent of maximum dry density by ASTM D698
	Cohensionless soils	75 percent of maximum relative density by ASTM D4253 and ASTM D4254
2. Common trench backfill:		
Under pavements roadways surfaces, D698 within highway right-of-ways, adjacent to retaining walls	Cohesive soils	95 percent of maximum dry density by ASTM D698
	Cohensionless soils	75 percent of maximum relative density by ASTM D4253 and ASTM D4254
Under turfed, sodded plant seeded, non-traffic areas	Cohesive soils	95 percent of maximum dry density by ASTM D698
	Cohensionless soils	75 percent of maximum relative density by ASTM D4253 and ASTM D4254

4. Ensure backfill materials have moisture content within three (3) percent of optimum moisture content at the time of placement.

3.10 FLUSHING AND TESTING OF SEWER PIPE AND STRUCTURES

A. Obstruction - After backfilling, all sewers lines shall be inspected for obstructions and shall be flushed with water. Flushing shall be a minimum velocity of 2.5 feet per second for a duration acceptable to the Engineer. Flushing shall remove all dirt, stones, pieces of wood and other debris which accumulated in the sewer during construction. The Contractor shall provide a means acceptable to the Engineer for removal of debris flushed from each section of sewer. If after flushing, any obstructions remain, they shall be removed at the Contractor's expense.

B. Visual Inspection - Sewer lines shall be visually inspected from every manhole by use of mirrors, television cameras, or other devices for visual inspection, and the lines shall all exhibit a fully circular pattern when viewed from one manhole to the next. Lines which do not exhibit a true line and grade or have structural defects shall be corrected to meet these qualifications.

C. Leakage - Sewers shall be tested for leakage. The program of testing shall fit the conditions as mutually determined by the Engineer and the Contractor. The Contractor shall take all necessary precautions to prevent any joints from drawing while the sewers or their appurtenances are being tested. The Contractor shall, at his own expense, correct any excess leakage and repair any damage to the pipe and their appurtenances, or to any structures resulting from or caused by these tests.

D. Leakage Test Procedure – Each section of sewer shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers and filling the pipe and manhole with water to a point 6 feet above the crown of the open sewer in the upper manhole, or, if ground water is present, 6 feet above the sections average adjacent ground water level as indicated by a monitor well installed adjacent to each manhole. The line shall be filled with water prior to testing and allowed to stand until the pipe has reached its maximum absorption, but not less than two (2) hours. After maximum absorption has been reached, the head shall be re-established and tested for at least six (6) hours maintaining the head specified above by measured additions of water. The sum of these additions shall be the leakage for the test period

If ground water is present to a height of at least 6 feet above the crown of the sewer at the upper end of the pipe section to be tested, the leakage test may be made by measuring the rate of infiltration using a suitable weir o rother measuring device approved by the Engineer. Whether the test is made by infiltration or exfiltration, the allowable leakage shall not exceed 100 gallons per day per inch of diameter per mile of sewer being tested.

Where the actual leakage exceeds the allowable, the Contractor shall discover the cause and correct it before the sewer will be accepted. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

E. Low Pressure Compressed Air Test - If the leakage cannot be located by infiltration or exfiltration testing, this type test may be used. The pipeline shall be considered acceptable, when tested at an average pressure of 3.0 psi greater than the average back pressure of any groundwater that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.0030 cfm per sq. ft. of internal pipe surface.

F. Deflection Test - No sooner than thirty (30) days after final backfill installation, each section of PVC pipe shall be checked for vertical deflection using an electronic deflecto-meter or a rigid "Go-No-Go" device. Vertical deflection shall not exceed five (5) percent of the inside pipe diameter for PVC pipe.

Where the actual deflection exceeds the allowable, the Contractor shall discover the cause and correct it before the pipe will be acceptable. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stub outs for future connections.

3.11 LEAKAGE TEST FOR MANHOLES

A. All manholes shall be vacuum tested as specified below. Refer to Section 15000 – Basic Mechanical Requirements for pipe testing methods and requirements.

B. <u>Manhole vacuum testing shall include the following minimum requirements:</u>

1. Testing shall be done in accordance with ASTM C1244-05 (or latest revision).

2. Prior to testing, all pipes, holes, and vents entering manhole shall be plugged and braced.

3. Contractor shall have an approved test head and copy of instructions for use by the manufacturer.

4. Contractor shall furnish two (2) certified and calibrated vacuum test gauges for the test.

5. A vacuum of 10-inch hg shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut-off. The time for the vacuum pressure to drop to 9-inch hg shall be measured. If the test time meets or exceeds the test time as specified in Table 2, the manhole is acceptable; otherwise, the test has failed and the manhole should be checked for leaks, repaired and re-tested.

Table 2
Minimum Vacuum Test Times (Seconds) for Various Manhole Diameters and Depths

Manholes Ø (inches)							
Depth (ft)	**48**	**60**	**72**	**84**	**96**	**108**	**120**
6'	15	20	25	29	34	38	43
8	20	26	33	38	45	51	57
10	25	33	41	48	56	63	71
12	30	39	49	57	67	76	85
14	35	46	57	67	78	89	100
16	40	52	67	76	89	101	114
18	45	59	73	86	100	114	128
20	50	65	81	95	111	126	142
22	55	72	89	105	122	139	156
24	59	78	97	114	133	152	170
26	64	85	105	124	144	164	185
28	69	91	113	133	155	177	199
30	74	98	121	143	166	189	213
Add. VF	+2.5	+3.25	+4.0	+4.75	+5.5	+6.5	+7.0

3.12 INFILTRATION

A. Any visible water infiltration of water into the manhole will be repaired using hydraulic cement or other approved material.

3.13 COST OF TESTING AND REPAIRS

A. Any and all work necessary to bring the line into conformance with the infiltration and deflection specifications shall be performed by the Contractor at no extra cost to the Owner. All apparent sources of infiltration and excessive deflection shall be repaired by the Contractor.

B. The Contractor shall provide all water, plugs, hoses, pumps, equipment, etc. necessary for the proper flushing and testing of the structures, sewer pipes, and storm drain pipes.

- END OF SECTION -

SECTION 02831

STEEL FENCING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install steel fencing, posts, gates, etc., where shown on the Drawings and in compliance with these Specifications.

B. Fencing shall be of the chain link type topped with barbed wire. The 6-foot high fabric shall clear the final grade by 3 inches, and shall be topped with three strands of barbed wire. The barbed wire shall be angled outward at the top. All components which are to be galvanized shall be hot dipped galvanized, coating to be 1.8 ounces per square foot of surface. Alternate coatings which employ a zinc coating of less than 1.8 ounces per square foot are not acceptable.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete.

1.03 SUBMITTALS

A. Shop Drawings shall be furnished in accordance with Section 01300, Submittals.

PART 2 -- PRODUCTS

2.01 CHAIN LINK FABRIC

A. Fabric shall be 9 gauge aluminum coated wire woven in a 2-inch diamond mesh conforming to ASTM A491. Top and bottom selvage to have a barbed finish. Minimum weight of coating shall be 0.40 ounce per square foot of wire surface. The coated wire shall have a minimum tensile strength of 80,000 lbs. per square inch.

B. Install fabric 3 inches above ground level. Fence shall be stretched tight and securely fastened to posts at points spaced 12 inches apart maximum.

C. Top and bottom selvage to have a twisted finish at one end and a knuckle finish at the other end.

2.02 POSTS

A. Posts and rails shall be galvanized standard weight pipe conforming to the requirements of ASTM F1083.

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1. Line Posts: Line posts shall be Schedule 40, 2-3/8 inch O.D. galvanized pipe with minimum bending strength of 201 pounds under a 6-foot cantilever load. Line posts shall be spaced at a maximum 10-foot O.C.

2. Terminal Posts: All end, corner, intermediate, and pull posts and gate leaves 6'0" wide and less shall be 2-7/8 inch O.D. galvanized Schedule 40 pipe with minimum bending strength of 381 pounds on 6-foot cantilever load. Gate posts for gate leaves shall be Schedule 40 pipe complying with ASTM F1083 of diameters as follows:

Gate Leaf Width	Pipe O.D.	Weight per Ft.
0' to 6'	2-7/8"	5.79 lbs.
Over 6' to 13'	4"	9.1 lbs.
Over 13' to 18'	6-5/8"	18.97 lbs.
Over 18'	8-5/8"	24.7lbs.

2.03 TENSION WIRE

A. Top and bottom tension wire shall be No. 7 gauge aluminum coated steel wire. Fabric shall be securely tied to tension wire at intervals not to exceed 24-inches.

2.04 POST TOPS AND BARBED WIRE SUPPORTS

A. Gate, end, corner and line post tops shall be malleable iron or pressed steel and shall be hot dipped galvanized conforming to ASTM A153.

B. Extension arms for supporting the three (3) strands of barbed wire for line posts shall be of pressed steel with malleable iron base, or solid aluminum alloy castings.

C. Angles for line post extension arms shall be approximately 45 degrees from the vertical and the top slot for barbed wire shall be a minimum of 12 inches above the fabric and a minimum of 10 inches from the fence line.

2.05 BARBED WIRE

A. Barbed wire shall consist of three strands of 12-1/2 gauge aluminum coated steel wire with 4-point barbs of 14 gauge aluminum wire spaced 5 inches apart, conforming to ASTM A585.

B. Additional strands of barbed wire shall be added beneath the chain link fabric at all ditch crossings to maintain the security of the fence installation.

2.06 BRACES, TOP RAILS AND TENSION BARS

A. Braces, top rails and tension bars shall be 1.66-inch O.D., Schedule 40 galvanized pipe with minimum vertical bending strength of 202 pounds on 10-foot span.

B. Top rails shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion. Tension bars shall be continuous and shall extend the height of fence fabric. Braces, rails and bars shall be provided at all terminal posts, located between the top and grade lines and extend from the terminal post to the first adjacent post. Braces shall be securely fastened at both ends. Brace ends for receiving brace rails shall be malleable iron or castings of 356.0 (formerly SG70A) alloy, or equivalent of ASTM B26 or B108.

C. Truss and stretcher bands shall be 1/8-inch x 7/8-inch pressed steel, supplied with carriage bolts and nuts. Bolts shall be 5/16-inch by 1 1/4-inch. Truss rods shall be 3/8-inch nominal diameter.

2.07 FABRIC TIES

A. Wire ties shall be preformed 0.148-inch diameter (9 gauge) aluminum. Flat band type ties shall be 1100-H18 or 3003-H14, .064-inch thick by 1/2-inch wide.

B. Hog rings for attaching tension wire to fabric shall be 0.105-inch diameter, Alloy 1100-H14.

2.08 GATES

A. Gate frames shall be made of 2-inch O.D. ASTM F1083 pipe, 2.72 lbs. per foot hot dipped galvanized. Fabric shall match fence. Gate frames shall be welded or assembled with riveted corner castings. Gate frames shall be equipped with 3/8-inch diameter adjustable truss bars. Hinges shall be ball and socket.

B. Gates shall be equipped with positive latching device with provision for padlocking. Personnel and access gates clear opening dimensions shall be as shown on the Drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All line posts shall be spaced equidistant in the fence line on a maximum of 10-foot centers. Posts shall be set plumb in concrete bases as detailed on Drawings. The top of the posts shall be brought to a smooth grade line. The wire fence shall be set accurately to line and grade and shall be plumb.

B. End, corner, pull or intermediate posts shall be placed in the following locations: corners; changes in direction; abrupt changes in grade; intervals no greater than 500 feet in the fence line. Each end or gate post shall have one brace assembly and each corner or intermediate post shall have two brace assemblies.

C. Horizontal braces shall be provided at all terminal posts, corner posts, and intermediate posts between top rail and ground and shall extend from the above-mentioned posts to

the first adjacent line posts. Braces shall be securely fastened to the line posts by brace ends and brace bands and to the terminal posts by approved rail end connectors. Diagonal brace rods shall be trussed from the brace end on the line post back to the terminal post, corner post or intermediate post and fastened to it by an approved connector.

3.02 POST FOUNDATIONS

A. Post holes shall be in true alignment and of sufficient size to provide a permanent foundation of concrete. Holes shall be well centered on the posts. A minimum diameter of 12 inches shall be required for all posts.

B. Post foundations shall be carefully rodded or tamped into place. The top of concrete shall extend 2 inches above ground line and shall be neatly troweled and leveled up from edges to the posts so as to have a pitch outward in all directions.

C. No materials shall be installed on the posts, nor shall any load be applied to the posts within 3 days after the individual post foundation is completed.

D. All concrete shall be Class "B" in conformance with Section 03300, Cast-in-Place Concrete.

3.03 RESETTING OF EXISTING FENCE

A. Where shown on the Drawings that resetting of existing fence is required, the fence, after resetting, shall be in a condition that is equal to or better than before the fence was removed.

B. The Contractor shall replace any of the fence components which have been unnecessarily damaged by him.

3.04 PADLOCK AND KEYS

A. One solid brass padlock shall be furnished with each gate. Padlocks shall be master keyed to City Standards

3.05 TEMPORARY FENCING

A. The Contractor shall furnish and install all temporary fencing and appurtenances as shown on the Drawings or as required during construction to adequately secure the site prior to installation of the permanent fence.

- END OF SECTION -

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SECTION 02910

FINAL GRADING AND LANDSCAPING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment, and materials necessary for final grading, topsoiling, seeding, and miscellaneous site work not included under other Sections, but required to complete the work as shown on the Drawings and specified herein. Under this Section, all areas of the project site disturbed by excavation, materials storage, temporary roads, etc., shall be reseeded as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02276 - Erosion and Sedimentation Control.

B. Section 02500 - Surface Restoration.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.

1. Product Data
2. Certification of all materials
3. Three (3) copies of composition and germination certification and of test results for grass seed.

PART 2 -- PRODUCTS

2.01 CONTRACTOR'S RESPONSIBILITIES

A. Furnish and submit certification for the materials used as specified in the General Conditions, Division 1 and Division 2.

2.02 TOPSOIL

A. Upon completion and Engineer’s approval of the rough grading, the Contractor shall place the topsoil over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped. Topsoil shall not be placed in a frozen or muddy condition and shall contain no toxic materials harmful to grass growth. Topsoil shall be as defined under Section 02200 - Earthwork.

2.03 WATER

A. Water shall be furnished to the Contractor by the Owner from existing facilities as directed by the Engineer.

B. The Contractor shall furnish all hoses and connections necessary to complete the landscaping work.

2.04 FERTILIZER

A. Fertilizer shall be a complete commercial fertilizer with components derived from commercial sources. Fertilizer composition shall be determined from field soil sampling in appropriate number taken by the Contractor and analyzed by the Cooperative Extension Service Soil Testing Laboratory at VPI & SU or by a reputable commercial laboratory. Contractor shall furnish fertilizer in accordance with the recommendations of the testing laboratory and Section 3.32 of the Virginia Erosion and Sediment Control Handbook (VESCH).

B. Fertilizer shall be delivered in standard size bags marked with the weight, analysis of contents, and the name of the manufacturer. Fertilizer shall be stored in weatherproof storage areas and in such a manner that its effectiveness will not be impaired.

2.05 LIME

A. Contractor shall use an agricultural grade of limestone. Quantity shall be determined from field soil sampling in appropriate number taken by the Contractor and analyzed by the Cooperative Extension Service Soil Testing Laboratory at VPI & SU or by a reputable commercial laboratory. Contractor shall furnish lime in accordance with the recommendations of the testing laboratory and Section 3.32 of the VESCH.

B. At least 50% shall pass a No. 200 U.S.S. mesh sieve. At least 90% shall pass a No. 100 U.S.S. mesh sieve and 100% shall pass a No. 10 U.S.S. mesh sieve. Total carbonates shall not be less than 80% or 44.8% Calcium Oxide equivalent. For the purpose of calculation, total carbonates shall be considered as Calcium Carbonate.

2.06 GRASS SEED

A. Provide the kinds and amounts of seed to be seeded in areas disturbed by the construction work. All seed shall bear an official “Certified Seed” labeled and meet the requirements in Section 3.32 of the VESCH. All seed must have been certified by Virginia Crop Improvement Association within twelve (12) months immediately preceding the planting of such material on the job.

B. The inoculant for treating legume seed mixture shall be a pure culture of nitrogen-fixing bacteria prepared specifically for the species. Inoculants shall not be used later than the date indicated on the container. Inoculants should be applied at two times the supplier’s recommended rate on dry seedings and five times the recommended rate when included in hydroseeder slurry. The quality of the seed shall conform to the following:

Type	Minimum Seed Purity (%)	Minimum Germination (%)	Maximum Weed Seed (%)
Kentucky 31 Tall Fescue	97	85	0.50
Perennial Ryegrass	98	90	0.50
Annual Ryegrass	97	90	0.50
Weeping Lovegrass	98	87	0.50
German Millet	98	85	0.50
Cereal (Winter) Rye	98	85	0.50

C. Seed mixtures to be used on the project shall be as follows:

P - 190#/acre Kentucky 31 Tall Fescue , 50#/acre Perennial Ryegrass, 5#/acre Kentucky Bluegrass

TW - 50#/acre Annual Ryegrass, 50#/acre Cereal (Winter) Rye

TSP -- 100#/acre Annual Ryegrass

TSU -- 50#/acre German Millet

Note:
PW - Permanent Seeding
TW - Temporary Winter Seeding
TSP - Temporary Spring Seeding
TSU - Temporary Summer Seeding

D. On cut and fill slopes 2:1 or steeper add 20#/acre of Weeping Lovegrass to the P seed mixture in the Spring and add 20#/acre Annual Ryegrass in Fall and Winter.

2.07 WOOD CELLULOSE FIBER MULCH

A. For use in hydroseeding grass seed in combination with fertilizers and other approved additions, shall consist of especially prepared wood cellulose fibers such as "Conwed", "Silva-Fiber", or approved substitute, and have no growth or germination inhibiting factors, and be dyed green.

B. The wood cellulose fiber shall have the additional characteristic of dispersing rapidly in water to form a homogeneous slurry and remain in such state when agitated in the hydraulic mulching unit, or adequate equal, with the specified materials.

C. When applied, the wood cellulose fiber with additives will form an absorptive mat but not a plant inhibiting membrane, which will allow moisture, natural or mechanical, to percolate into underlying soil.

D. Fiber mulch can be applied over top of newly seeded areas immediately after seed mixture is applied to soil bed or applied as part of the hydroseeded slurry containing the seed mixture. Anchored straw mulch shall be used in place of fiber mulch during hot and dry

summer months and late fall. Fiber mulch can be used to tack (anchor) straw mulch. All fiber mulch shall adhere to requirements set forth in Section 3.35 of the VESCH.

E. The mulch shall be supplied, compressed in packages containing 50 pounds of material having an equilibrium air dry moisture content at time of manufacture of 12% plus or minus 2%. Wood cellulose fiber mulch shall be stored in a weatherproof storage area and in such a manner that effectiveness will not be impaired.

2.08 STRAW MULCH

A. Straw used for mulch shall be wheat or oats. Straw shall be undamaged, air dry, threshed straw, free of undesirable weed seed. Straw mulch shall be spread by hand or machine and must be anchored or tacked down. Straw mulch is not required for seeded areas treated with a temporary soil stabilizer. All straw mulch shall adhere to requirements set forth in Section 3.35 of the VESCH.

2.09 TEMPORARY SOIL STABILIZER

A. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as "Enviroseal 2001" by Enviroseal Corporation, "Terra Control" by Quattro Environmental, Inc., or "CHEM-CRETE ECO-110" by International CHEM-CRETE Corporation, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.

2.10 SOIL STABILIZATION BLANKET (SSB)

A. The SSB shall be as specified in Section 02276 - Erosion and Sedimentation Control.

2.11 SYNTHETIC SOIL STABILIZATION MAT (SSM)

A. The SSM shall be as specified in Section 02276 – Erosion and Sedimentation Control.

2.12 RIPRAP AND HERBICIDES

A. Furnish and install sufficient quantity of landscape gravel or riprap to cover over the ground to a minimum 4-inch depth for gravel and 24-inch depth for riprap, unless otherwise noted, or indicated on the Drawings. Also furnish and apply an approved herbicide to the subgrade surface just prior to installing the landscape gravel or riprap.

B. During placing, the stone shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone.

C. All topsoil and vegetative matter shall be removed from the subgrade surfaces prior to the application of the weed killer (herbicide) and to the placement of landscape gravel or riprap. Apply commercial-type herbicide as preemergence control of miscellaneous grasses and broadleaf weeds in granular or liquid form such as "Treflan", "Dymid", or approved

substitute. Methods and rates of application shall be in strict compliance to manufacturer's directions and acceptable to the Engineer.

D. The herbicide selected shall be safe for use around ornamental plantings, have long-lasting weed control, and shall be resistant to leaching away under excessive rainfall.

E. A second application of the herbicide shall be made on the surface of the landscape gravel or riprap sometime after the first six (6) months, but not later than twelve (12) months. Same methods and rates apply as specified previously.

2.13 TREE SHRUB PLANTING

A. Provide trees and shrubs as shown on the Drawings and as specified in Section 3.37 of VESCH.

PART 3 -- EXECUTION

3.01 GRADING

A. After approval of the rough grading, the Contractor shall commence his preparations of the subgrade for the various major conditions of the work as follows:

1. Bare soil for riprap area at subgrade (24-inches below final grade, or as directed by the Engineer).

2. Topsoil for lawn and road shoulder seed area - scarify 2-inch depth of subgrade (4-inches below final grade) prior to placing topsoil.

B. Final surface grading of the topsoiled, landscape graveled, and riprapped areas shall be mechanically raked or hand raked to an even finished surface alignment.

3.02 TOPSOIL

A. Topsoil shall be spread in place for quantity required for lawn and road shoulder seed areas at 4-inch consolidated depth, and sufficient quantity for certain plant beds and backfill for shrubs and trees as specified.

B. Topsoil shall be hospitable as a growth medium meeting all requirements as indicated by Sections 3.30 & 3.32 of VESCH.

3.03 SOIL STABILIZATION BLANKET (SSB)

A. All channels and slopes indicated on the Drawings shall be lined with a SSB. The area to be covered shall be properly graded and hydroseeded before the blanket is applied. Installation shall be in accordance with Section 02276, Erosion and Sedimentation Control.

3.04 SOIL STABILIZATION MAT (SSM)

A. All channels and slopes indicated on the Drawings shall be lined with a SSM. The area to be covered shall be properly graded before the mat is applied. Once the mat is placed and anchored, the area shall be seeded and mulched in accordance to this Specification and Section 3.36 of the VESCH. Installation shall be in accordance with Section 02276, Erosion and Sediment Control.

3.05 CLEANUP

A. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.

B. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

3.06 SEEDING SCHEDULE

A. All seeding and mulching to be completed by the Contractor shall conform to Sections 3.32 and 3.35 of the VESCH. No permanent seeding shall be performed from May 1 – August 31 and November 1 – February 31. Temporary seed mixtures will be used during these times if seeding is necessary. Areas seeded with temporary seed mixtures shall be reseeded by the Contractor at no additional cost to the Owner with permanent seed as directed by the Engineer.

B. Application rates of seed mixtures, lime, fertilizer, mulch and top dressing are shown in the schedule.

SEEDING SCHEDULE

Application Rates (Pounds/Acre)

Seed[b] Mixture	Planting Season	Lime[a]	Seed	Fertilizer[a,d]	Straw[e] Mulch	Topdressing[a]	Annual Fertilizer	Comments
P	Feb. 15-April 30 Sept. 1-Oct. 31	4000	200	1000 of 10-20-10	4000	500 of 10-10-10 60 of Nitrogen	Same as Topdressing	Preferred planting seasons are Sept. 1 – Sept. 31 and Feb 15 – March 30.
TW	Sept. 1-Feb. 15	-[c]	100	600	4000	-	-	Over seed with Type P seed mixture during next planting season.
TSP	Feb. 16-Apr. 30	-[c]	100	600	4000	-	-	Over seed with Type P seed mixture during next planting season.
TSU	May 1-Aug. 31	-[c]	50	600	4000	-	-	Over seed with Type P seed mixture during next planting season.

Footnotes:

a. Application rates and/or chemical analysis shall be confirmed or established by soil test.

b. On cut and fill slopes 2:1 or steeper add 20#/acre of Weeping Lovegrass to the P seed mixture in the Spring and add 20#/acre Annual Ryegrass in Fall and Winter.

c. Lime requirements for temporary seeding shall be based on pH test results for site, according to the following table:

pH Test	Recommended Application
Below 4.2	3 tons/acre
4.2 to 5.2	2 tons/acre
5.2 to 6	1 ton/acre

d. Fertilizer shall be a 10-20-10 mix or equivalent nutrients.

e. Alternative methods of mulching may be utilized. Alternative methods shall conform to requirements in the Virginia Erosion and Sediment Control Handbook.

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SECTION 03100

CONCRETE FORMWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03200 - Reinforcing Steel

B. Section 03250 - Concrete Accessories

C. Section 03290 - Joints in Concrete

D. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2. ACI 318 - Building Code Requirements for Structural Concrete

3. ACI 301 - Specifications for Structural Concrete for Buildings

4. ACI 347 - Recommended Practice for Concrete Formwork

5. U.S. Product Standard for Concrete Forms, Class I, PS 1

6. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Manufacturer's data on proposed form release agent

2. Manufacturer's data on proposed formwork system including form ties

1.05 QUALITY ASSURANCE

A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

PART 2 -- PRODUCTS

2.01 FORMS AND FALSEWORK

A. All forms shall be smooth surface forms unless otherwise specified.

B. Wood materials for concrete forms and falsework shall conform to the following requirements:

1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.

C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

2.02 FORMWORK ACCESSORIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed mechanical EPDM rubber plug shall be used to seal the hole left after the removal of the taper tie. Plug shall be X-Plug by the Greenstreak Group, Inc., or approved equal. Friction fit plugs shall not be used.

C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

PART 3 -- EXECUTION

3.01 FORM DESIGN

A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.

B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.

C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

3.02 CONSTRUCTION

A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.

B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.

C. Forms shall be true to line and grade, and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.

D. Forms shall be mortar tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and

paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form.

E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.

G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.

H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.

I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.

J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

3.03 TOLERANCES

A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.

B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.

C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

D. Regardless of the tolerances specified, no portion of the building shall extend beyond the legal boundary of the building.

3.04 FORM ACCESSORIES

A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.

B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to water or enclosed surfaces above the water surface, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 - Concrete Finishing. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

3.05 APPLICATION - FORM RELEASE AGENT

A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

3.06 INSERTS AND EMBEDDED ITEMS

A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

3.07 FORM CLEANING AND REUSE

A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.08 FORM REMOVAL AND SHORING

A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.

B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

Ambient Temperature (°F.) During Concrete Placement					
	Over 95°	**70°-95°**	**60°-70°**	**50°-60°**	**Below 50°**
Walls	5 days	2 days	2 days	3 days	Do not remove until directed by Engineer (7 days minimum)
Columns	7 days	2 days	3 days	4 days	
Beam Soffits	10 days	7 days	7 days	7 days	
Elevated Slabs	12 days	7 days	7 days	7 days	

C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.

D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall be available for inspection at all times at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.

3.09 RESHORING

A. When reshoring is permitted or required the operations shall be planned in advance and subjected to approval by the Engineer.

B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.

C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.

D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.

E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

- END OF SECTION -

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SECTION 03200

REINFORCING STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.

B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03250 - Concrete Accessories

C. Section 03300 - Cast-in-Place Concrete

D. Section 03400 - Precast Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice

3. ACI SP66 - ACI Detailing Manual

4. ACI 315 - Details and Detailing of Concrete Reinforcing

5. ACI 318 - Building Code Requirements for Structural Concrete

6. ICC-ES AC193 - Acceptance Criteria for Expansion and Screw Anchors (Concrete)

7. WRI - Manual of Standard Practice for Welded Wire Fabric

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8. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing

9. ASTM A 1064 - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.

2. Mill test certificates - 3 copies of each.

3. Description of the reinforcing steel manufacturer's marking pattern.

4. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.

5. Proposed supports for each type of reinforcing.

6. Request to use splices not shown on the Drawings.

7. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.

8. Request for placement of column dowels without the use of templates.

9. Request and procedure to field bend or straighten partially embedded reinforcing.

10. International Code Council–Evaluation Services Report (ICC-ES ESR) for dowel adhesives.

11. Certification that all installers of dowel adhesive are certified as Adhesive Anchor Installers in accordance with the ACI-CRSI Anchor Installer Certification Program.

12 Adhesive dowel testing plan.

1.05 QUALITY ASSURANCE

A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be

paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.

B. Provide a list of names of all installers who are trained by the Manufacturer's Field Representative on this jobsite prior to installation of products. Record must include the installer name, date of training, products included in the training and trainer name and contact information.

C. Provide a copy of the current ACI/CRSI "Adhesive Anchor Installer" certification cards for all installers who will be installing adhesive anchors in the horizontal to vertically overhead orientation.

PART 2 -- PRODUCTS

2.01 REINFORCING STEEL

A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type and grade. All reinforcing bars shall be deformed bars. Smooth reinforcing bars shall not be used unless specifically called for on Drawings.

B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 1064 and the details shown on the Drawings.

C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.

D. Field welding of reinforcing steel will not be allowed.

E. Use of coiled reinforcing steel will not be allowed.

2.02 ACCESSORIES

A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers and other devices to position reinforcing during concrete placement. Wire bar supports shall be plastic protected (CRSI Class 1).

B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

2.03 MECHANICAL COUPLERS

A. Mechanical couplers shall develop a tensile strength which exceeds 100 percent of the ultimate tensile strength and 125 percent of the yield strength of the reinforcing bars being spliced. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.

C. Hot forged sleeve type couplers shall not be used. Acceptable mechanical couplers are Dayton Superior Dowel Bar Splicer System by Dayton Superior, Dayton, Ohio, or approved equal. Mechanical couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.

D. Where the threaded rebar to be inserted into the coupler reduces the diameter of the bar, the threaded rebar piece shall be provided by the coupler manufacturer.

2.04 DOWEL ADHESIVE SYSTEM

A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions.

B. All holes shall be drilled in accordance with the manufacturer’s instructions except that core drilled holes shall not be permitted unless specifically allowed by the Engineer. Cored holes, if allowed by the manufacturer and approved by the Engineer, shall be roughened in accordance with manufacturer’s requirements.

C. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with manufacturer’s instructions prior to installation of adhesive and reinforcing bar.

D. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water-saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer.

E. Injection of adhesive into the hole shall be performed in a manner to minimize the formation of air pockets in accordance with the manufacturer’s instructions.

F. Embedment Depth:

1. The embedment depth of the bar shall be as shown on the Drawings. Although all manufacturers listed below are permitted, the embedment depth shown on the Drawings is based on “Pure 110+” by DeWalt” ESR 3298 issued 7/2016. If the Contractor submits one of the other named dowel adhesives from the list below, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.

2. Where the embedment depth is not shown on the Drawings, the embedment depth shall be determined to provide the minimum allowable bond strength equal to the tensile strength of the rebar according to the manufacturer's ICC-ES ESR.

3. The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long term temperature of 110 degrees F, and maximum short term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum, or more than the maximum, embedment depths stated in the manufacturer's ICC-ES ESR.

G. Engineer's approval is required for use of this system in locations other than those shown on the Drawings.

H. The adhesive system shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories and shall be "Epcon C6+ Adhesive Anchoring System" as manufactured by ITW Redhead, " HIT-HY 200 Adhesive Anchoring System" as manufactured by Hilti, Inc. "SET-XP Epoxy Adhesive Anchors" as manufactured by Simpson Strong-Tie Co. or "Pure 110+ Epoxy Adhesive Anchor System" by DeWalt. Fast-set epoxy formulations shall not be acceptable. No or equal products will be considered, unless pre-qualified and approved.

I. All individuals installing dowel adhesive system shall be certified as an Adhesive Anchor Installer in accordance with the ACI-CRSI Anchor Installation Certification Program.

PART 3 – EXECUTION

3.01 TEMPERATURE REINFORCING

A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.0033 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0020 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 18 inches.

3.02 FABRICATION

A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.

B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.

C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved to be bent in the field.

Reinforcing bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars will not be permitted.

D. Welded wire fabric with longitudinal wire of W9.5 size or smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches. Welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.

3.03 DELIVERY, STORAGE AND HANDLING

A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.

B. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.

C. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

3.04 PLACING

A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or plastic protected (CRSI Class 1) metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.

B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8 inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.

C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.

E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.

F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.

G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.

H. Reinforcing shall not be straightened or rebent unless specifically shown on the drawings. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.

I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations and as required in Article 2.04 above. A representative of the manufacturer must be on site prior to adhesive dowel installation to provide instruction on proper installation procedures for all adhesive dowel installers. Testing of adhesive dowels shall be as indicated below. If the dowels have a hook at the end to be embedded in subsequent work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate adhesive dowel testing while maintaining required hook embedment in subsequent work.

J. All adhesive dowel installations in the horizontal or overhead orientation shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI per ACI 318-11 9.2.2. Current AAI Certificated must be submitted to the Engineer of Record for approval prior to commencement of any adhesive anchor installations.

K. Adhesive Dowel Testing

1. At all locations where adhesive dowels are shown on the Drawings, at least 10 percent of all adhesive dowels installed shall be tested to the value indicated on the Drawings, with a minimum of one tested dowel per group. If no test value is indicated on the Drawings but the installed dowel is under direct tension, the Contractor shall notify the Engineer to verify the required test value.

2. Contractor shall submit a plan and schedule indicating locations of dowels to be tested, load test values and proposed dowel testing procedure (including a diagram of the testing equipment proposed for use) prior to conducting any testing. The testing equipment shall have a minimum of three support points and shall be of sufficient size to locate the edge of supports no closer than two times the anchor embedment depth from the center of the anchor.

3. Where Contract Documents indicate adhesive dowel design is the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of dowels to be tested and load test values, sealed by a Professional Engineer currently registered in the Commonwealth of Virginia. The Contractor shall also submit documentation indicating the Contractor's testing procedures

have been reviewed and the proposed procedures are acceptable.

4. Adhesive Dowel shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the dowel after loading shall be considered a failure. Dowels exhibiting damage shall be removed and replaced. If more than 5 percent of tested dowels fail, then 100 percent of dowels shall be proof tested.

5. Proof testing of adhesive dowels shall be performed by an independent testing laboratory hired directly by the Contractor. The Contractor shall be responsible for costs of all testing, including additional testing required due to previously failed tests.

3.05 SPLICING

A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.

B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.

C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

D. Mechanical splices shall be used only where shown on the drawings or when approved by the Engineer.

E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

3.06 INSPECTION

A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.

B. The Contractor shall advise the Engineer of his intentions to place grout in masonry walls and shall allow him adequate time to inspect all reinforcing steel before grout is placed.

3.07 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete without prior approval.

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SECTION 03250

CONCRETE ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, contraction joint inserts, and epoxy bonding agent.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03290 - Joints in Concrete

C. Section 03300 - Cast-in-Place Concrete

D. Section 07900 - Joint Fillers, Sealants, and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C881 — Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

2. ASTM D412 — Standard Tests for Rubber Properties in Tension

3. ASTM D 624 — Standard Test method for Rubber Property - Tear Resistance

4. ASTM D 638 — Standard Test Method for Tensile Properties of Plastics

5. ASTM D1751 — Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (nonextruding and resilient bituminous types)

6. ASTM D 1752 — Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

7. ASTM D 1171 — Standard Test Method for Ozone Resistance at 500 pphm

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8. ASTM D 471 Standard Test Method for Rubber Properties

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Manufacturer's literature on all products specified herein including material certifications.

2. Proposed system for supporting PVC waterstops in position during concrete placement

3. Samples of products if requested by the Engineer.

PART 2 -- PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

A. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.

B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.

C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.

D. The required minimum physical characteristics for this material are:

1. Tensile strength - 1,750 psi (ASTM D-638).

2. Ultimate elongation - not less than 280% (ASTM D-638).

E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.

F. PVC waterstops shall be as manufactured by BoMetals, Inc., DuraJoint Concrete Accessories, or Sika Greenstreak.

G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

2.02 EXPANDING RUBBER WATERSTOP

A. Expanding rubber shall be designed to expand under hydrostatic conditions. Waterstops shall be Adeka Ultra Seal MC-2010MN by Adeka Ultra Seal/OCM, Inc., or Hydrotite CJ-1020-2K by Sika Greenstreak, for concrete thickness greater than nine inches. For thicknesses less than nine inches, Adeka Ultra Seal KBA-1510FF or Hydrotite CJ-1020-2K shall be used.

B. Waterstop shall be a chemically modified natural rubber product with a hydrophilic agent.

C. Waterstop has a stainless steel mesh or coextrusion of non-hydrophilic rubber to direct expansion in the thickness direction and restrict the expansion in the longitudinal direction.

2.03 WATERSTOP ADHESIVE

A. Adhesive between waterstops and existing concrete shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

B. Hydrophilic, non-bentonite water swelling elastic sealant shall be used to bond expanding rubber waterstops to rough surfaces. Hydrophilic elastic sealant shall be P-201 by Adeka Ultra Seal/OCM, Inc., Leakmaster LV-1 by Sika Greenstreak, or approved equal.

2.04 JOINT SEALANTS

A. Joint sealants shall comply with Section 07900, Joint Fillers, Sealants, and Caulking.

2.05 EXPANSION JOINT MATERIAL

A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:

1. Type I - Sponge rubber, conforming to ASTM D1752, Type I.

2. Type II - Cork, conforming to ASTM D1752, Type II.

3. Type III - Self-expanding cork, conforming to ASTM D1752, Type III.

4. Type IV - Bituminous fiber, conforming to ASTM Designation D1751.

2.06 EXPANSION JOINT SEAL

A. Expansion Joint Seal System shall consist of a preformed neoprene profile, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive and pressurized during the adhesive cure time.

B. The expansion joint system shall be Hydrozo/Jeene Structural Sealing joint system by Hydrozo/Jeene, Inc.

2.07 CONTRACTION JOINT INSERTS

A. Contraction joint inserts shall be Zip-Cap by Greenstreak Plastic Products, Zip-Joint by BoMetals, Inc. control joint formers.

2.08 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, MasterInject 1500 by BASF Master Builder Solutions (BASF).

2.09 EPOXY RESIN BINDER

A. Epoxy resin binder shall conform to the requirements of ASTM C-881, Type III, Grade 3, Class B and C for epoxy resin binder and shall be Sikadur 23, Low-Mod-Gel, manufactured by the Sika Corporation, Lyndhurst, N.J., Flexocrete Gel manufactured by DuraJoint Concrete Accessories or Euco #352 Gel, Euclid Chemical Company, MasterEmaco ADH 327 or 327 RS by BASF Master Builder Solutions.

PART 3 -- EXECUTION

3.01 PVC AND CHEMICAL RESISTANT WATERSTOPS

A. PVC and chemical resistant waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.

B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.

C. Splices in PVC waterstops and chemical resistant waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at all intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an

approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.

D. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, discoloration, charring, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.

E. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:

1. Tensile strength not less than 80 percent of parent material.

2. Overlapped (not spliced) Waterstop.

3. Misalignment of Waterstop geometry at any point greater than 1/16 inch.

4. Visible porosity or charred or burnt material in weld area.

5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

3.02 WATERSTOP ADHESIVE

A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.

B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

3.03 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS

A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.

B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.

C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.

E. Type 1 joint sealant shall be used in all expansion and contraction joints in concrete, except where Type 7 or Type 8 is required as stated below, and wherever else specified or shown on the Drawings. It shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.

F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.

G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

3.05 CONTRACTION JOINT INSERTS

A. For contraction joints in slabs, inserts shall be floated in fresh concrete during finishing.

B. For contraction joints in walls, inserts shall be secured in place prior to casting wall.

C. Inserts shall be installed true to line at the locations of all contraction joints as shown on the Drawings.

D. Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290, Joints in Concrete.

E. Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

3.06 EPOXY BONDING AGENT

A. The Contractor shall use an epoxy bonding agent for bonding fresh concrete to existing concrete as shown on the Drawings.

B. Bonding surface shall be clean, sound and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.

C. Application of bonding agent shall be in strict accordance with manufacturer's recommendations.

D. Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

3.07 EPOXY RESIN BINDER

A. Epoxy resin binder shall be used to seal all existing rebar cut and burned off during demolition operations. Exposed rebar shall be burned back 1/2-inch minimum into existing concrete and the resulting void filled with epoxy resin binder.

- END OF SECTION -

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SECTION 03290

JOINTS IN CONCRETE

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.

B. Types of joints in concrete shall be as follows:

1. Construction Joints - Joints between adjacent concrete placements continuously connected with reinforcement.

2. Expansion Joints - Joints in concrete which allow thermal expansion and contraction of concrete. Reinforcement terminates within concrete on each side of joint.

3. Contraction Joints - Joints formed in concrete to provide a weakened plane in concrete section to control formation of shrinkage cracks.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03250 - Concrete Accessories

C. Section 03300 - Cast-in-Place Concrete

D. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 - Specifications for Structural Concrete for Buildings

2. ACI 318 - Building Code Requirements for Structural Concrete

3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

4. ACI 224.3 – Joints in Concrete Construction

1.04 SUBMITTALS

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A. Submit the following in accordance with Section 01300, Submittals.

1. Layout drawings showing location and type of all joints to be placed in each structure.

2. Details of proposed joints in each structure.

3. For sawcut contraction joints submit documentation indicating the following:

a. Proposed method of sawcutting indicating early entry or conventional sawing.

b. Description of how work is to be performed including equipment to be utilized, size of crew performing the work and curing methods.

c. Description of alternate method in case of time constraint issues or failure of equipment.

PART 2 -- MATERIALS

2.01 MATERIALS

A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories, and Section 07900 - Joint Fillers, Sealants and Caulking.

PART 3 -- EXECUTION

3.01 CONSTRUCTION JOINTS

A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and its location to Engineer for approval.

B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

C. Maximum distance between horizontal joints in slabs and vertical joints in walls shall be 45'-0". For exposed walls with fluid or earth on the opposite side, the spacing between vertical and horizontal joints shall be a maximum of 25’-0”.

D. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.

E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.

F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

3.02 EXPANSION JOINTS

A. Size and location of expansion joints shall be as shown on the Drawings.

B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250, Concrete Accessories.

3.03 CONTRACTION JOINTS

A. Location of contraction joints shall be as shown on the Drawings.

B. Contraction joints shall be formed either by sawcutting or with contraction joint inserts as specified in Section 03250, Concrete Accessories. Sawcutting of joints will not be permitted unless specifically approved by the Engineer.

C. If approved by the Engineer, saw cutting of contraction joints in lieu of forming shall conform to the following requirements:

1. Joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.

2. Curing shall be performed using wet curing methods as indicated in Section 03370 – Concrete Curing. Curing mats, fabrics or sheeting materials shall remain in place to the extent possible while cutting of joint is being performed. Curing materials shall only be removed as required and shall be immediately reinstalled once cutting of the joint has been completed.

3. Depth of joint shall be as shown on the drawings or noted in these specifications. At locations where the joint cannot be installed to full depth due to curbs or other stopping points hand tools shall be used to complete joints.

4. Saw cut joints shall meet the requirements of ACI 224.3, Section 2.8, Jointing Practice.

D. Unless noted otherwise on Drawings, depth of contraction joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

3.04 JOINT PREPARATION

A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.

C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.

D. All joints shall be sealed as shown on the Drawings and specified in Section 03250, Concrete Accessories.

- END OF SECTION -

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide all labor, equipment, materials and services necessary for the manufacture, transportation and placement of all plain and reinforced concrete work, as shown on the Drawings or as ordered by the Engineer.

B. The requirements in this section shall apply to the following types of concrete:

1. Class A1 Concrete: Normal weight structural concrete to be used in all structures qualifying as environmental concrete structures that are designed in accordance with ACI 350 including pump stations, tanks, basins, process structures, and any structures containing fluid or process chemicals or other materials used in treatment process.

2. Class A2 Concrete: Normal weight structural concrete in all structures other than structures qualifying as environmental concrete structures as described above, and for all sidewalks and pavement.

3. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03200 - Reinforcing Steel

C. Section 03250 - Concrete Accessories

D. Section 03290 - Joints in Concrete

E. Section 03350 - Concrete Finishes

F. Section 03370 - Concrete Curing

G. Section 03600 - Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2. ACI 214 Guide to Evaluation of Strength Test Results of Concrete

3. ACI 301 Specifications for Structural Concrete

4. ACI 304 Guide for Measuring, Mixing, Transporting, and Placing Concrete

5. ACI 305 Guide to Hot Weather Concreting

6. ACI 306 Guide to Cold Weather Concreting

7. ACI 309 Guide for Consolidation of Concrete

8. ACI 318 Building Code Requirements for Structural Concrete and Comentary

9. ACI 350 Code Requirements for Environmental Engineering Concrete Structures

10. ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field

11. ASTM C 33 Standard Specification for Concrete Aggregates

12. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

13. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

14. ASTM C 88 Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate

15. ASTM C 94 Standard Specification for Ready-Mixed Concrete

16. ASTM C 114 Standard Test Method for Chemical Analysis of Hydraulic Cement

17. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

18.	ASTM C 138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
19.	ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
20.	ASTM C 150	Standard Specification for Portland Cement
21.	ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
22.	ASTM C 192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
23.	ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
24.	ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
25.	ASTM C 295	Standard Guide for Petrographic Examination of Aggregates for Concrete
26.	ASTM C 457	Standard Test Method for Microscopical Determination of the Air-Void System in Hardened Concrete
27.	ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
28.	ASTM C 595	Standard Specification for Blended Hydraulic Cements
29.	ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
30.	ASTM C 989	Standard Specification for Slag Cement for Use in Concrete and Mortars
31.	ASTM C 1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
32.	ASTM C 1260	Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
33.	ASTM C 1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
34.	ASTM C 1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

35. ASTM C 1778 Reducing the Risk of Deleterious Alkali – Aggregate Reaction in Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Sources of all materials and certifications of compliance with specifications for all materials.

2. Certified current (less than 1 year old) chemical analysis of the Portland Cement or Blended Cement to be used.

3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.

4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, potential reactivity, aggregate soundness tests, petrographic analysis, mortar bar expansion testing, etc.

5. Manufacturer's data on all admixtures stating compliance with required standards.

6. Concrete mix design for each class of concrete specified herein.

7. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.

1.05 QUALITY ASSURANCE

A. Tests on materials used in the production of concrete shall be required as specified in PART 2 -- PRODUCTS. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.

B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner.

C. Field quality control tests, as specified in Article 3.10, unless otherwise stated, will be performed by a materials testing consultant employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

PART 2 -- PRODUCTS

2.01 HYDRAULIC CEMENT

A. Portland Cement

1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.02 or 2.03 respectively.

2. When potentially reactive aggregates as defined in Article 2.05 are to be used in concrete mix, cement shall meet the following requirements:

   a. For concrete mixed with only Portland Cement, the total alkalies in the cement (calculated as the percentage of NA_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.40%.

   b. For concrete mixed with Portland Cement and an appropriate amount of fly ash (Article 2.02) or slag cement (Article 2.03) the total alkalies in the Portland Cement (calculated as the percentage of NA_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%.

3. When non-reactive aggregates as defined in Article 2.05 are used in concrete mix, total alkalies in the cement shall not exceed 1.0%.

4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

B. Blended Cement

1. Blended cements shall be Type IP (Portland Fly Ash Cement) or Type IS (Portland Slag Cement) conforming to ASTM C 595.

2. Type IP cement shall be an interground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.

3. Type IS cement shall be an interground blend of Portland Cement and slag cement in which the slag constituent is between 35% and 50% of the weight of the total blend.

4. Fly ash and slag cement used in the production of blended cements shall meet the requirements of Articles 2.02 and 2.03, respectively.

5. When reactive aggregates as defined in Article 2.05 are used in concrete mix, the total alkalies in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%. The percentage of fly ash or slag cement shall be set to meet provisions of Article 2.05.G.2.

C. Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same

brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

D. Cement shall be stored in a suitable weather-tight building so as to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

2.02 FLY ASH

A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618.

B. For fly ash to be used in the production of type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.

C. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.

D. For Type A1 concrete as required for use in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.

E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

2.03 SLAG CEMENT

A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.

B. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the slag cement constituent shall be between 35% and 40% of the total weight of the combined Portland Cement and slag. The percentage of slag cement shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.

C. For Type A1 concrete as required for use in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.

D. Additional slag cement shall not be included in concrete mixed with type IS or IP cement.

2.04 WATER

A. Water used for mixing concrete shall be clear, potable and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts and other impurities.

B. Water shall not contain more than 100 PPM chloride.

C. Water shall not contain more than 500 PPM dissolved solids.

D. Water shall have a pH in the range of 4.5 to 8.5.

E. Water shall meet requirements of ASTM C 1602.

2.05 AGGREGATES

A. All aggregates used in normal weight concrete shall conform to ASTM C 33.

B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.

C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.

D. For Class A4 concrete, coarse aggregate shall be Size #8 in accordance with ASTM C33.

E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.

F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using either magnesium sulfate or sodium sulfate.

G. All aggregates shall be evaluated in accordance with ASTM C 1778 to determine potential reactivity. All aggregates shall be considered reactive unless they meet the requirements below for non-reactive aggregates. Aggregates with a lithology essentially similar to sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.

1. Non-reactive aggregates shall meet the following requirements:

   A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:

(a) Optically strained, microfractured, or microcrystalline quartz, 5.0%, maximum.

(b) Chert or chalcedony, 3.0%, maximum.

(c) Tridymite or cristobalite, 1.0%, maximum.

(d) Opal, 0.5%, maximum.

e) Natural volcanic glass in volcanic rocks, 3.0%, maximum.

2. Concrete mixed with reactive aggregates shall meet the following requirements:

(a) If aggregates are deemed potentially reactive as per ASTM C-1778 and fly ash or slag cement is included in proposed concrete mix design, proposed concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.

(b) If aggregates are deemed potentially reactive as per ASTM C-1778 and a straight cement mix without fly ash or slag cement is proposed for concrete mix design, aggregates shall be evaluated by ASTM C-1260. Mean mortar bar expansions at 16 days shall be less than 0.08%.

H. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

2.06 ADMIXTURES

A. Air entraining agent shall be added to all concrete unless noted otherwise. The agent shall consist of a neutralized vinsol resin solution or a purified hydrocarbon with a cement catalyst which will provide entrained air in the concrete in accordance with ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be obtained and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.

B. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set. Admixtures permitted shall confirm to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.

1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are “Eucon Series” by the Euclid Chemical Company, “Master Pozzolith Series” by BASF, and “Plastocrete Series” by Sika Corporation.

2. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete

at either the batch plant or at the job site and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are "Eucon 37" or Plastol 5000 by the Euclid Chemical Company, "Master Rheobuild 1000 or Master Glenium Series" by BASF, and "Daracem 100 or Advaflow Series" by W.R. Grace.

3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E, and shall not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are "Accelguard 80/90 or NCA" by the Euclid Chemical Company and "Daraset" by W.R. Grace.

4. A water reducing retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type D and shall not contain more than 0.05% chloride ions. Acceptable products are "Eucon NR or Eucon Retarder 100" by the Euclid Chemical Company, "Pozzolith Retarder" by BASF, and "Plastiment" by Sika Corporation.

C. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are <u>not</u> permitted. The addition of admixtures to prevent freezing is not permitted.

D. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review.

2.07 CONCRETE MIX DESIGN

A. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete strength results shall be from concrete mixed with all of the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. Contractor shall submit verification confirming this stipulation has been followed. Field experience records and/or trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.

B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.

1. Compressive Strength (28-Day)

a.	Concrete Class A1	4,500 psi (minimum)
b.	Concrete Class A2	4,000 psi (minimum)
c.	Concrete Class B	3,000 psi (minimum)

2. Water/cementitious materials ratio, by weight

		Maximum	Minimum
a.	Concrete Class A1	0.42	0.39
b.	Concrete Class A2	0.45	0.39
c.	Concrete Class B	0.50	0.39

3. Slump range — 4" nominal unless high range water reducing admixture is used.
8" max if high range water reducing admixture is used.

4. Air Content

a.	Class A1, A2	6% ±1.5%
b.	Class B	3% Max (non air-entrained)

PART 3 -- EXECUTION

3.01 TRIAL MIXES

A. When trial mixes are used to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350, an independent qualified testing laboratory designated and retained by the Contractor shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PART 2 -- PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.

B. The independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and unit weight (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. _____, Product _____." If the

average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

3.02 PRODUCTION OF CONCRETE

A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready mix plant or from a site mixed plant. In selecting the source for concrete production the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.

B. Ready-Mixed Concrete

1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.

2. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed before the drum has been revolved 300 revolutions and within the time requirements stated in Article 3.03 of this Section.

6. Each and every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:

   a. Date and truck number
   b. Ticket number
   c. Mix designation of concrete
   d. Cubic yards of concrete
   e. Cement brand, type and weight in pounds
   f. Weight in pounds of fine aggregate (sand)
   g. Weight in pounds of coarse aggregate (stone)
   h. Air entraining agent, brand, and weight in pounds and ounces
   i. Other admixtures, brand, and weight in pounds and ounces
   j. Water, in gallons, stored in attached tank
   k. Water, in gallons, maximum that can be added without exceeding design water/cementitious materials ratio
   l. Water, in gallons, actually used (by truck driver)
   m. Time of loading
   n. Time of delivery to job (by truck driver)

7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.

8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Scales for weighing concrete ingredients shall be accurate when in use within ±0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.

2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:

a.	Cement, fly ash, or slag cement	± 1 percent
b.	Water	± 1 percent
c.	Aggregates	± 2 percent
d.	Admixtures	± 3 percent

3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which

may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

4. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.

5. Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

6. Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.

7. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.

8. Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.

9. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.

10. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.

11. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.

12. Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.

13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

3.03 CONCRETE PLACEMENT

A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.

B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures which are subsequently required.

C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture or cement grout shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. Concrete or cement grout shall meet all strength and service requirements specified herein for applicable class of concrete. This concrete shall be worked well into the irregularities of the hard surface.

D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.

E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided that the design water-cementitious materials ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix that meets all specified requirements.

F. Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.09 of this Section.

G. Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise.

H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds. Concrete shall be placed in all forms in such way as to prevent any segregation.

I. Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.

J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet and a sufficient number shall be placed in the form to ensure the concrete is kept level at all times.

K. When placing concrete which is to be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.

L. Concrete shall be placed so as to thoroughly embed all reinforcement, inserts, and fixtures.

M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. To achieve this, concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.

N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in the area of freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.

O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration, however, shall not be continued in any one location to the extent that pools of grout are formed.

P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.

Q. To prevent featheredges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.

R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators so as to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations from the aforementioned to the Engineer for review and approval.

S. Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

3.04 PLACING FLOOR SLABS ON GRADE

A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the materials testing consultant.

B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50° long enough to remove all frost from the subgrade.

C. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.

D. Thirty-pound felt paper shall be provided between edges of slab-on-grade and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.

E. Contraction joints shall be provided in slabs-on-grade at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03290 - Joints in Concrete.

F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03350 - Concrete Finishes. Interior floor slabs shall be placed with non-air-entrained concrete (Class A3) if a steel troweled or hardened finish is required.

3.05 PLACING CONCRETE UNDERWATER (CLASS A5 CONCRETE)

A. Placing concrete underwater (tremie concrete) will be permitted only when shown on the Drawings. Concrete deposited under water shall be carefully placed in a compacted mass in final position by means of a tremie, a closed bottom dump bucket or other approved method. Care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. Underwater formwork shall be watertight. The consistency of the concrete shall be regulated to prevent segregation of materials. The method of depositing concrete shall be regulated such that the concrete enters the mass of the previously placed concrete from within, displacing water with a minimum disturbance to the surface of the concrete.

B. Tremie shall consist of a tube having a diameter of not less than 10 inches and constructed in sections having flanged couplings fitted with gaskets. The tremie shall be supported to permit free movement of the discharge and over the entire top surface of the work and shall permit rapid lowering when necessary to choke off or retard the flow. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The flow shall be continuous until the placement has been completed.

3.06 PLACING CONCRETE UNDER PRESSURE

A. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

B. Priming of the concrete pumping equipment shall be with cement grout only. Use of specialty mix pump primers or pumping aids will not be allowed.

C. No aluminum parts shall be in contact with the concrete during the entire placing of concrete under pressure at any time.

D. Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a materials testing consultant proving the proposed mix meets all requirements. In addition, an actual pumping test under field conditions is required prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used; the same pump and operator shall be present and the pipe and pipe layouts will reflect the maximum height and distance contemplated. All submissions shall be subject to approval by the Engineer.

E. If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

F. The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.

G. The minimum diameter of the hose (conduits) shall be four inches.

H. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.

I. Concrete samples for quality control in accordance with Article 3.10 will be taken at the placement (discharge) end of the line.

3.07 ORDER OF PLACING CONCRETE

A. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

3.08 CONCRETE WORK IN COLD WEATHER

A. Cold weather concreting procedures shall conform to the requirements of ACI 306.

B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed the aforementioned minimum values by more than 20°F, unless otherwise approved by the Engineer.

C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature in excess of 100°F. in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.09 CONCRETE WORK IN HOT WEATHER

A. Hot weather concreting procedures shall conform to the requirements of ACI 305.

B. When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the Contractor and his

concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation and the Engineer reserves the right to modify the proposed measures consistent with the requirements of this Section of the Specifications. All necessary materials and equipment shall be on hand an in position prior to each placing operation.

C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.

D. The temperature of the concrete mix when placed shall not exceed 90°F.

E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.

F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched.

G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

3.10 QUALITY CONTROL

A. Field Testing of Concrete

1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the materials testing consultant personnel as required for concrete testing.

2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall provide assistance to the materials testing consultant in obtaining samples. The Contractor shall dispose of and clean up all excess material.

B. Consistency

1. The consistency of the concrete will be checked by the materials testing consultant by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer and/or the materials testing consultant may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No

payment shall be made for any delays, material or labor costs due to such eventualities.

2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.

3. Concrete with a specified nominal slump shall be placed having a slump within 1" (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Unit Weight

1. Samples of freshly mixed concrete shall be tested for unit weight by the materials testing consultant in accordance with ASTM C 138.

2. Unit weight tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the materials testing consultant in accordance with ASTM C 231.

2. Air content tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.

3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the materials testing consultant and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein.

2. In general, one sampling shall be taken for each placement in excess of five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.

3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The materials testing consultant will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.

4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders for testing. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens from falling over, being jarred or otherwise disturbed during the period of initial curing. The box shall be erected, furnished and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds and such that all specimen are shielded from direct sunlight and/or radiant heating sources. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.

5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of test specimens with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day curing box contains test specimens. Temperature shall be recorded a minimum of three times a day with one recording at the start of the work day and one recording at the end of the work day.
6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.

7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.

2. The strength level of concrete will be considered satisfactory if all of the following conditions are satisfied.

   a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.08).

   b. No individual compressive strength test results falls below the minimum specified strength by more than 500 psi.

3. In the event any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.

4. In the event that condition 2B is not met, additional tests in accordance with Article 3.10, paragraph H shall be performed.

5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:

   a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.

   b. Maintain or add temporary structural support as required.

   c. Correct the mix for the next concrete placement operation, if required to remedy the situation.

6. All concrete which fails to meet the ACI requirements and these specifications is subject to removal and replacement at no additional cost to the Owner.

G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.

H. Additional Tests

1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.

2. In the event the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.10, paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.

   a. Three cores shall be taken for each sample in which the strength requirements were not met.

   b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by a materials testing consultant approved by the Engineer.

   c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.

   d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.

e. The diameter of core specimens should be at least 3 times the maximum nominal size of the course aggregate used in the concrete, but must be at least 2-inches in diameter.

f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.

g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.

h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.

3. In the event that concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage a materials testing consultant approved by the Engineer, to obtain and test samples for air content in accordance with ASTM Specification C 457.

3.11 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed.

C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed.

D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an approved epoxy injection system. Non-structural cracks shall be repaired using an approved hydrophilic resin pressure injected grout system, unless other means of repair are deemed

necessary and approved. All repair work shall be performed at no additional cost to the Owner.

E. Concrete which fails to meet the strength requirements as outlined in Article 3.10, paragraph F, will be analyzed as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be as directed by the Engineer.

- END OF SECTION -

SECTION 03350

CONCRETE FINISHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03300 – Cast-in-Place Concrete

C. Section 03600 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 – Specifications for Structural Concrete for Buildings

2. ACI 318 – Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Manufacturer's literature on all products specified herein.

PART 2 -- PRODUCTS

2.01 CONCRETE FLOOR SEALER

A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, MasterKure CC 300 SB by BASF Master Builder Solutions.

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PART 3 -- EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.

1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.

3.02 SLAB AND FLOOR FINISHES

A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.

1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a concrete rake to 1/2” minimum deep grooves prior to final set.

2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a

wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.

3. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.

3.03 CONCRETE SEALERS

A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.

B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.

C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.

D. All slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 CONCRETE FINISH SCHEDULE

Item	**Type of Finish**
Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures:	
From 1 feet below water surface to bottom of wall	I
From top of wall to 1 feet below water surface	II
Exterior concrete walls below grade	I
Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere	II
Floors of process equipment tanks or basins, wetwells, flow channels and slabs to receive roofing material or waterproof membranes	B
Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather	E

- END OF SECTION -

SECTION 03370

CONCRETE CURING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03300 – Cast-In-Place Concrete

C. Section 03350 – Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 – Specifications for Structural Concrete for Buildings

2. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete

3. ACI 305 – Hot Weather Concreting

4. ACI 306 – Cold Weather Concreting

5. ACI 308 – Standard Practice for Curing Concrete

6. ASTM C171 – Standard Specifications for Sheet Materials for Curing Concrete

7. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

8. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Proposed procedures for protection of concrete under wet weather placement conditions.

2. Proposed normal procedures for protection and curing of concrete.

3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.

4. Proposed method of measuring concrete surface temperature changes.

5. Manufacturer's literature and material certification for proposed curing compounds.

PART 2 -- PRODUCTS

2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m^2 when applied at 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, MasteKure CC 300 SB by BASF Master Builder Solutions, and Cure & Seal 30 Plus by Symons Corporation.

B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurez DR VOX" or "Kurez W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

2.02 EVAPORATION REDUCER

A. Evaporation reducer shall be BASF, "MasterKure ER 50", or Euclid Chemical "Euco-Bar".

PART 3 -- EXECUTION

3.01 PROTECTION AND CURING

A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.

B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.

C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.

D. The Contractor shall use one of the following methods to insure that the concrete remains in a moist condition for the minimum period stated above.

1. Ponding or continuous fogging or sprinkling.

2. Application of mats or fabric kept continuously wet.

3. Continuous application of steam (under 150°F).

4. Application of sheet materials conforming to ASTM C171.

5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.

E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.

F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.

B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.

C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.

D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sun shades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.

B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.

C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.

D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least six (6) additional days using one of the methods listed in paragraph 3.01D.

E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.

B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.

C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

3.05 EARLY TERMINATION OF CURING

A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:

1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.

2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

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SECTION 03400

PRECAST CONCRETE

PART 1 -- GENERAL

1.01 REQUIREMENTS

A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02604 - Utility Structures

B. Section 03200 - Reinforcing Steel

C. Section 03300 - Cast-in-Place Concrete

D. Section 03350 - Concrete Finishes

E. Section 03370 - Concrete Curing

F. Section 03600 - Grout

G. Section 05010 - Metal Materials

H. Section 05035 - Galvanizing

I. Section 05050 - Metal Fastening

J. Section 05830 - Bearing Devices

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the end of the Bid.

1. Virginia Uniform Statewide Building Code

2. ACI 318-Building Code Requirements for Structural Concrete

3. PCI Standard MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products

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4. PCI Design Handbook

1.04 SUBMITTALS

A. The Contractor shall submit the following for review in accordance with Section 01300, Submittals.

1. Shop drawings for all precast concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.

2. A list of the design criteria used by the manufacturer for all manufactured, precast items.

3. Design calculations, showing at least the design loads and stresses on the item, shall be submitted. Calculations shall be signed and sealed by a Professional Engineer registered in the Commonwealth of Virginia.

4. Certified reports for all lifting inserts, indicating allowable design loads.

5. Information on lifting and erection procedures.

1.05 QUALITY ASSURANCE

A. All manufactured precast concrete units shall be produced by an experienced manufacturer regularly engaged in the production of such items. All manufactured precast concrete and site-cast units shall be free of defects, spalls, and cracks. Care shall be taken in the mixing of materials, casting, curing and shipping to avoid any of the above. The Engineer may elect to examine the units at the casting yard or upon arrival of the same at the site. The Engineer shall have the option of rejecting any or all of the precast work if it does not meet with the requirements specified herein or on the Drawings. All rejected work shall be replaced at no additional cost to the Owner.

B. Manufacturer Qualifications

The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of production. Certification is only required for plants providing prestressed structural members such as hollow core planks, double-T members, etc.

C. Plant production and engineering must be under direct supervision and control of an Engineer who possesses a minimum of five years experience in precast concrete work.

PART 2 -- PRODUCTS

2.01 CONCRETE

A. Concrete materials including portland cement, aggregates, water, and admixtures shall conform to Section 03300, Cast-in-Place Concrete.

B. For prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 5,000 psi unless otherwise specified. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi unless otherwise specified.

C. For non-prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 4000 psi unless otherwise specified.

2.02 GROUT

A. Grout for joints between panels shall be a cement grout in conformance with Section 03600, Grout.

B. Minimum compressive strength of grout at 7 days shall be 3,000 psi.

2.03 REINFORCING STEEL

A. Reinforcing steel used for precast concrete construction shall conform to Section 03200, Reinforcing Steel.

2.04 PRESTRESSING STRANDS

A. Prestressing strands shall be 7-wire, stress-relieved, high-strength strands Grade 250K or 270K.

2.05 STEEL INSERTS

A. Steel inserts shall be in accordance with Section 05010, Metal Materials.

B. All steel inserts protruding from or occurring at the surface of precast units shall be galvanized in accordance with Section 05035, Galvanizing.

2.06 WELDING

A. Welding shall conform to Section 05050, Metal Fastening.

2.07 BEARING PADS

A. Neoprene bearing pads shall conform to Section 05830, Bearing Devices and Anchors.

B. Plastic bearing pads shall be multi-monomer plastic strips which are non-leaching and support construction loads with no visible overall expansion, manufactured specifically for the purpose of bearing precast concrete.

PART 3 -- EXECUTION

3.01 FABRICATION AND CASTING

A. All precast members shall be fabricated and cast to the shapes, dimensions and lengths shown on the Drawings and in compliance with PCI MNL-116. Precast members shall be straight, true and free from dimensional distortions, except for camber and tolerances permitted later in this clause. All integral appurtenances, reinforcing, openings, etc., shall be accurately located and secured in position with the form work system. Form materials shall be steel and the systems free from leakage during the casting operation.

B. All cover of reinforcing shall be the same as detailed on the Drawings.

C. Because of the critical nature of the bond development length in prestressed concrete panel construction, if the transfer of stress is by burning of the fully tensioned strands at the ends of the member, each strand shall first be burned at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.

D. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.

E. Concrete shall be finished in accordance with Section 03350, Concrete Finishes. Grout all recesses due to cut tendons which will not otherwise be grouted during erection.

F. Curing of precast members shall be in accordance with Section 03370, Concrete Curing. Use of a membrane curing compound will not be allowed.

G. The manufacturer shall provide lifting inserts or other approved means of lifting members.

3.02 HANDLING, TRANSPORTING AND STORING

A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28 day compressive strength and a period of at least 5 days has elapsed since casting, unless otherwise permitted by the Engineer.

B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.

C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.

D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.

E. Precast concrete members shall not be used as storage areas for other materials or equipment.

F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

3.03 ERECTION

A. Erection shall be carried out by the manufacturer or under his supervision using labor, equipment, tools and materials required for proper execution of the work.

B. Contractor shall prepare all bearing surfaces to a true and level line prior to erection. All supports of the precast members shall be accurately located and of required size and bearing materials.

C. Installation of the precast members shall be made by leveling the top surface of the assembled units keeping the units tight and at right angles to the bearing surface.

D. Connections which require welding shall be properly made in accordance with Section 05050, Metal Fastening.

E. Grouting between adjacent precast members and along the edges of the assembled precast members shall be accomplished as indicated on the drawings, care being taken to solidly pack such spaces and to prevent leakage or droppings of grout through the assembled precast members. Any grout which seeps through the precast members shall be removed before it hardens.

F. In no case shall concentrated construction loads, or construction loads exceeding the design loads, be placed on the precast members. In no case shall loads be placed on the precast members prior to the welding operations associated with erection, and prior to placing of topping (if required).

G. No Contractor, Subcontractor or any of his employees shall arbitrarily cut, drill, punch or otherwise tamper with the precast members.

H. Precast members damaged while being erected will be rejected or shall be repaired in a manner approved by the Engineer.

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SECTION 03452

ARCHITECTURAL PRECAST CONCRETE UTILITY BUILDINGS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install Architectural Precast Concrete Utility Buildings as shown on the Drawings and as specified herein.

B. Work shall include all coordination and reinforcements for openings and support of light fixtures, heating and ventilation units, etc., as shown and required for a complete installation.

B. Architectural Precast Concrete Utility Building supplier shall be exclusively responsible for the structural design of a complete precast concrete building envelope system.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 03200 - Reinforcing Steel

C. Section 03400 - Precast Concrete

D. Section 03600 - Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Virginia Uniform Statewide Building Code

B. ACI 318-Building Code Requirements for Structural Concrete

C. PCI Standard MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products

D. PCI Design Handbook

1.04 SUBMITTALS

A. Shop Drawings shall be furnished in accordance with Section 01300 - Submittals.

B. Color charts and samples of architectural finishes shall be provided. All architectural finishes and colors to be selected by Owner from manufacturer's standard finishes.

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C. Engineering calculations that are designed and sealed by a professional engineer currently registered in the Commonwealth of Virginia. The calculations shall be submitted to the Engineer prior to building fabrications and concrete foundation placement.

D. Dimensioned shop drawings showing the modular building plans including all vertical and lateral building reactions to the foundation, detailed anchorage of building to the cast-in-place concrete foundation, elevations, cross-sections and lifting locations and procedures. Shop drawings shall be signed and sealed by a professional engineer currently registered in the Commonwealth of Virginia.

PART 2 -- PRODUCT

2.01 ARCHITECTURAL PRECAST CONCRETE ELECTRICAL BUILDING

A. Buildings shall be supplied and installed by the same manufacturer and have interior dimensions as follows:

11’ 6” x 15’-6” x 8'-0" high

B. Buildings shall consist of a prefabricated modular load-bearing roof and prefabricated modular walls to be erected on a formed cast-in-place concrete slab as shown on the Drawings.

C. Installation shall include all necessary anchors and equipment to secure the building and to ensure that the joints between the walls and slabs are watertight.

D. Buildings and accessories shall comply with the requirements of the applicable portions of the Virginia Uniform Statewide Building Code. Materials of construction shall conform to the applicable requirements of Section 03200 - Reinforcement Steel and Section 03400 - Precast Concrete.

E. The building shall be designed according to the applicable building codes. The modular load-bearing roof shall be capable of supporting a minimum live load of 35 psf and span the required distance without intermediate supports. The building shall also be designed to support snow drift loads from adjacent structures where required by site layout and code requirements and all seismic requirements. Roof shall have a overhang on all sides and be sloped as shown on Drawings..

F. Hollow Metal Door

1. Buildings shall have a double doors for a door opening sizes of 6’-0” x 6'-8" and a single door 3’-0”x 6’-8” steel door supplied by the building manufacturer and located as shown on the Drawings.

a. Steel doors shall have at a minimum, 18-gauge steel face and 16-gauge steel frames. Doors and frames shall be reinforced, stiffened, sound deadened, and insulated with foam-type core, completely filling the inside

of the door, and laminated to the inside faces of the face sheets. Core material shall have capillary rating of zero. Doors shall have a thickness of 1 ¾". Steel door frames shall have 2" exposed face.

b. Doors and frames shall be bonderized over galvanized surface and then be shop painted with a baked-on rust-inhibitive primer. Finish coatings shall consist of one 5 mil (minimum dry film thickness) coat of Tnemec Series 66 epoxy polyamide and one 5 mil (minimum dry film thickness) coat of Tnemec Series 1074 aliphatic polyurethane, or equal.

c. Any scratches, abrasions, or any damage to painted galvanized surfaces shall be cleaned and touched-up with a field application of paint as used in the shop.

d. Doors shall have the greatest degree of swing possible without touching exterior of building.

2. All hollow metal doors, frames, anchors, and steel accessories shall be galvanized by the hot dipped process. The coating shall be commercial class, weighing not less than 1.25 oz. per square foot in accordance with ASTM A 525. The zinc shall be applied in such a manner as to provide a ductile coating that is tightly bonded to both sides of the base metal. Galvanizing shall occur after all accessory work is completed.

3. All hollow metal doors and frames shall be mortised, reinforced, and drilled and tapped for hinges, lock strikes, and all other hardware at the factory. Drilling and tapping for surface hardware shall be done by the building manufacturer.

a. Doors shall be furnished with Sargent All Purpose Dormitory or Store Room Locks No. 18-7725, or equal. Lock trim shall be stainless steel. Lock cylinders shall be removable, and all locks shall be operated by the same key.

b. Hinges shall be Stanley Model FBB199 stainless steel, or equal. A minimum of three hinges shall be provided per door leaf.

c. Doors shall be furnished with stops and holders, Fenestra #9493, H.B. Ives #446B26D, or equal. Provide stops as required to keep door from hitting face of adjacent walls.

d. Weatherproofing shall be mounted in the corner of the door frame and shall be ASW 225 by Durable Products, 114 PFPS by Pemko, or equal.

4. Doors and fixed hollow metal panels shall be full flush design, stretcher leveled with no joints or seams in faces. Full length edge or mechanical interlocks shall be provided. Top and bottom of doors shall be of flush design. Doors shall swing out and the fixed hollow metal panels shall have a weather sealed cap or closure.

G. Caulking

1. All joints between panels shall be caulked interior and exterior surface of the joints. Caulking shall be SIKAFLEX 1A or approved equal. Provide backer rod or tape to prevent adhesion to the back of joint. Color shall be selected by Owner.

H. The location, size, and accessories of all openings and attachments for all trades shall be coordinated by the Contractor and shall be as shown on the Drawings as required for a complete installation.

I. The prefabricated roof and wall system shall be the EASI-SET precast building as manufactured by, or Smith-Midland Corporation in Midland, Va. or approved equal.

J. Exit signs shall be provided and mounted to be visible from all locations of the building.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All items specified herein shall be installed where indicated on the Drawings, or as directed by the Engineer.

B. Coordinate and verify foundation requirements prior to installation.

C. Architectural precast concrete utility building to be field assemble and made weather tight by the building manufacturer.

- END OF SECTION -

SECTION 03600

GROUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work and as bearing surfaces for base plates, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1.	CRD-C 621	Corps of Engineers Specification for Non-shrink Grout
2.	ASTM C 109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens)
3.	ASTM C 531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacings
4.	ASTM C 579	Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings
5.	ASTM C 827	Standard Test Method for Early Volume Change of Cementitious Mixtures
6.	ASTM C 144	Standard Specification for Aggregate for Masonry Mortar
7.	ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)

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1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.

1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.

2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of grout used in the work.

1.05 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. The specimens will be made by the Engineer or its representative.

a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.

b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.

2. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Engineer in obtaining specimens for testing. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens, at no additional cost to the Owner.

3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated,

cement grout shall consist of one part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White Portland Cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.

2. The minimum compressive strength at 28 days shall be 4000 psi.

3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness.

4. Sand shall conform to the requirements of ASTM C144.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "Euco N-S" by the Euclid Chemical Company, "Sikagrout 212" by Sika Corporation, “Conspec 100 Non-Shrink Non-Metallic Grout” by Conspec, “Masterflow 555 Grout” by BASF Master Builder Solutions.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "Euco #452 Series" by Euclid Chemical, “MasterEmaco ADH 1090 RS” by BASF Master Builder Solutions.

2. Epoxy grout shall be modified as required for each particular application with aggregate per manufacturer's instructions.

D. Epoxy Base Plate Grout

1. Epoxy base plate grout shall be “Sikadur 42, Grout-Pak” by Sika Corporation, or “Masterflow 648” by BASF Master Builder Solutions.

2.02 CURING MATERIALS

A. Curing materials shall be as specified in Section 03370, Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

PART 3 -- EXECUTION

3.01 GENERAL

A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.

1. Cement grout shall be used for grout toppings and for patching of fresh concrete.

2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing.

3. Epoxy grout shall be used for bonding new concrete to hardened concrete.

4. Epoxy base plate grout shall be used for precision seating of base plates including base plates for all equipment such as engines, mixers, pumps, vibratory and heavy impact machinery, etc.

B. New concrete surfaces to receive cement grout shall be as specified in Section 03350, Concrete Finishes, and shall be cleaned of all dirt, grease and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03370, Concrete Curing.

C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

D. The Contractor, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the Owner.

3.02 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

3.03 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

3.04 GROUT INSTALLATION

A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be

poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be poured from one side only and thence flow across to the open side to avoid air-entrapment.

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SECTION 05010

METAL MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Materials for fasteners are included in Section 05050, Metal Fastening.

B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM A36 Standard Specification for Structural Steel

B. ASTM A47 Standard Specification for Malleable Iron Castings

C. ASTM A48 Standard Specification for Gray Iron Castings

D. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

E. ASTM A167 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

F. ASTM A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes

G. ASTM A307 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

H. ASTM A446 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality

I. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

J. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

K. ASTM A529 Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)

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L. ASTM A536 Standard Specification for Ductile Iron Castings

M. ASTM A570 Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality

N. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

O. ASTM A992 Standard Specification for Structural Steel Shapes

P. ASTM A666 Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications

Q. ASTM A1085 Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)

R. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings

S. ASTM B85 Standard Specification for Aluminum-Alloy Die Castings

T. ASTM B108 Standard Specification for Aluminum-Alloy Permanent Mold Castings

U. ASTM B138 Standard Specification for Manganese Bronze Rod, Bar, and Shapes

V. ASTM B209 Standard Specification for Aluminum-Alloy Sheet and Plate

W. ASTM B221 Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

X. ASTM B308 Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded

Y. ASTM B574 Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod

Z. ASTM F468 Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

a. ASTM F593 Standard Specification for Stainless Steel Fasteners

1.04 SUBMITTALS

A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing

materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 -- PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

A. Material types and ASTM designations shall be as listed below:

1.	Steel W Shapes	A992
2.	Steel HP Shapes	A572 Grade 50
3.	Steel M, S, C, and MC shapes and Angles, Bars, and Plates	A36
4.	Rods	F 1554 Grade 36
5.	Pipe - Structural Use	A53 Grade B
6.	Hollow Structural Sections	A500 Grade C or A1085
7.	Cold-Formed Steel Framing	A 653

2.02 STAINLESS STEEL

A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.

B. Material types and ASTM designations are listed below:

1.	Plates and Sheets	ASTM A167 or A666 Grade A
2.	Structural Shapes	ASTM A276
3.	Fasteners (Bolts, etc.)	ASTM F593

2.03 ALUMINUM

A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

1.	Structural Shapes	ASTM B308
2.	Castings	ASTM B26, B85, or B108
3.	Extruded Bars	ASTM B221 - Alloy 6061
4.	Extruded Rods, Shapes and Tubes	ASTM B221 - Alloy 6063
5.	Plates	ASTM B209 - Alloy 6061
6.	Sheets	ASTM B221 - Alloy 3003

C. All aluminum structural members shall conform to the requirements of Section 05140, Structural Aluminum.

D. All aluminum shall be provided with mill finish unless otherwise noted.

E. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

1.	Gray	ASTM A48 Class 30B
2.	Malleable	ASTM A47
3.	Ductile	ASTM A536 Grade 60-40-18

2.05 BRONZE

A. Material types and ASTM designations are listed below:

1.	Rods, Bars and Sheets	ASTM B138 - Alloy B Soft

2.06 HASTELLOY

A. All Hastelloy shall be Alloy C-276.

2.07 DISSIMILAR METALS

A. Dielectric isolation shall be installed wherever dissimilar metals are connected according to the following table.

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Zinc			●	●	●	●	●	●	●
Galvanized Steel			●	●	●	●	●	●	●
Aluminum	●	●		●	●	●	●	●	●
Cast Iron	●	●	●				●	●	●
Ductile Iron	●	●	●				●	●	●
Mild Steel/ Carbon Steel	●	●	●				●	●	●
Copper	●	●	●	●	●	●			●
Brass	●	●	●	●	●	●			●
Stainless Steel	●	●	●	●	●	●	●	●	

1. "●" signifies dielectric isolation is required between the two materials noted.
2. Consult Engineer for items not listed in table.

PART 3 -- EXECUTION

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SECTION 05035

GALVANIZING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2. ASTM A123 - Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip

3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4. ASTM A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

4. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

5. ASTM A780 - Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings

6. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

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1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

PART 2 -- PRODUCTS

2.01 GALVANIC COATING

A. Material composition of the galvanic coating shall be in accordance with the applicable ASTM standards specified herein.

PART 3 -- EXECUTION

3.01 FABRICATED PRODUCTS

A. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.

B. Components with partial surface finishes shall be commercial blast cleaned prior to pickling.

C. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

3.02 HARDWARE

A. Iron and steel hardware which is to be galvanized shall be galvanized in accordance with ASTM A153 and ASTM F2329.

3.03 ASSEMBLED PRODUCTS

A. Assembled steel products which are to be galvanized shall be galvanized in accordance with ASTM A123. All edges of tightly contacting surfaces shall be completely sealed by welding before galvanizing.

B. Assemblies shall be provided with vent and drain holes as required by the fabricator. Vent and drain hole sizes and locations shall be included in the structural steel shop drawings required in Specification 05120 Structural Steel for approval. All vent and drain holes shall be plugged and finished to be flush with and blend in with the surrounding surface. Where water intrusion can occur, the plug shall be carefully melted into the surrounding zinc coating using an appropriate fluxing agent.

3.04 METAL DECK

A. Unless noted otherwise, metal deck shall be galvanized in accordance with ASTM A653 G60 minimum. In moist environments or as indicated on the Contract Drawings, galvanizing shall meet the requirements of ASTM A653 G90.

B. Galvanized metal deck shall meet the requirements of ASTM A924.

3.05 REPAIR OF GALVANIZING

A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

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SECTION 05050

METAL FASTENING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05035 – Galvanizing

C. Section 05061 – Stainless Steel

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2.	AC 193	Acceptance Criteria for Mechanical Anchors in Concrete Elements
3.	AC 308	Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
4.	ACI 318	Building Code Requirements for Structural Concrete
5.	ACI 355.2	Qualifications of Post-Installed Mechanical Anchors in Concrete
6.	ACI 355.4	Qualifications of Post-Installed Adhesive Anchors in Concrete
7.	ICC-ES AC193	Acceptance Criteria for Expansion and Screw Anchors (Concrete)
8.	AISC 348	The 2009 RCSC Specification for Structural Joints
9.	AISC	Code of Standard Practice

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10.	AWS D1.1	Structural Welding Code – Steel
11.	AWS D1.2	Structural Welding Code – Aluminum
12.	AWS D1.6	Structural Welding Code – Stainless Steel
13.	Aluminum Association	Specifications for Aluminum Structures
14.	ASTM A572/A572M-94C	Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
15.	ASTM A36	Standard Specification for Carbon Structural Steel
16.	ASTM A325	Standard Specification for High-Strength Bolts for Structural Steel Joints
17.	ASTM A489	Standard Specification for Eyebolts
18.	ASTM A490	Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
19.	ASTM A563	Standard Specifications for Carbon and Alloy Steel Nuts
20.	ASTM D1785	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
21.	ASTM E488	Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
22.	ASTM F436	Standard Specification for Hardened Steel Washers
23.	ASTM F467	Standard Specification for Nonferrous Nuts for General Use
24.	ASTM F593	Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
25.	ASTM F594	Standard Specification for Stainless Steel Nuts
26.	ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.

2. Anchor design calculations sealed by a Professional Engineer currently registered in the Commonwealth of Virginia. Only required if design not shown on Contract Drawings.

3. A current ICC-ES Evaluation Service Report shall be submitted for all anchors that will be considered for use on this project.

4. Manufacturer’s installation instructions.

5. Copy of valid certification for each person who is to perform field welding.

6. Certified weld inspection reports, when required.

7. Welding procedures.

8. Installer qualifications.

9. Certification of Installer Training.

10. Inspection Reports.

11. Results of Anchor Proof Testing.

1.05 QUALITY ASSURANCE

A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.

B. Installer Qualifications: All concrete anchors shall be installed by an Installer with at least three years of experience performing similar installations. Concrete adhesive anchor installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Installer Training: For concrete adhesive, expansion and screw anchors, conduct a thorough training with the manufacturer or the manufacturer’s representative for the Installer on the project. Training shall consist of a review of the complete installation process to include but not be limited to the following:

1. Hole drilling procedure.

2. Hole preparation and cleaning technique.

3. Adhesive injection technique and dispenser training/maintenance.

4. Concrete adhesive anchor preparation and installation.

5. Proof loading/torqueing.

6. Provide a list of names of all installers who are trained by the Manufacturer's Field Representative on this jobsite prior to installation of products. Record must include the installer name, date of training, products included in the training and trainer name and contact information

7. Provide a copy of the current ACI/CRSI "Adhesive Anchor Installer" certification cards for all installers who will be installing adhesive anchors in the horizontal to vertically overhead orientation.

D. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.

E. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.

F. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.

G. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.

H. Inspections of the adhesive dowel system shall be made by the Engineer or other representatives of the Owner in accordance with the requirements of the ESR published by the manufacturer. Provide adequate time and access for inspections of products and anchor holes prior to injections, installation, and proof testing.

PART 2 -- PRODUCTS

2.01 ANCHOR RODS (ANCHOR BOLTS)

A. Anchor rods shall conform to ASTM F1554 Grade 36 except where stainless steel or other approved anchor rods are shown on the Drawings. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.

B. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot-dip galvanized in accordance with ASTM F1554.

C. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.02 HIGH STRENGTH BOLTS

A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC 348 "The 2009 RCSC Specification for Structural Joints".

B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS

A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

2.04 CONCRETE ANCHORS

A. General

1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by an approved independent testing laboratory. There are two types used:

a. Expansion anchors shall be mechanical anchors of the wedge, sleeve, drop-in or undercut type.

b. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.

c. Concrete screw anchors shall be one piece, heavy duty screw anchor with a finished hex head

2. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.

3. Unless otherwise noted, all concrete anchors which are submerged or are used in hanging items or have direct tension induced upon them, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.

4. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Expansion, concrete screw or mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to the International Building Code and ACI 318 Appendix D requirements as applicable, including seismic test requirements.

5. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or anchor non-structural elements.

6. Engineer's approval is required for use of concrete anchors in locations other than those shown on the Drawings.

B. Concrete Anchor Design:

An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, it shall be considered an engineered design and anchors shall be installed to the prescribed size, spacing, embedment depth and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the anchors will be considered an engineered design and the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated by the Engineer on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

1. Structural Anchors: All concrete anchors shall be considered structural anchors if they transmit load between structural elements; transmit load between non-structural components that make up a portion of the structure and structural elements; or transmit load between life-safety related attachments and structural elements. Examples of structural concrete anchors include but are not limited to column anchor bolts, anchors supporting non-structural walls, sprinkler piping support anchors, anchors supporting heavy, suspended piping or equipment, anchors supporting barrier rails, etc. For structural anchors, the Contractor shall submit an engineered design with signed and sealed calculations performed by an Engineer currently registered in the Commonwealth of Virginia. Structural anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Appendix D.

2. Non-Structural Anchors: All other concrete anchors may be considered non-structural concrete anchors. The Contractor shall perform an engineered design for non-structural anchors. The Engineer may request the Contractor provide anchor design details for review, but submission of a signed, sealed design is not required. Non-structural anchors shall be designed by the contractor for use in uncracked concrete.

3. Embedment Depth

a. Minimum anchor embedment shall be as indicated on the Drawings or determined by the Contractor's engineered design. Although all manufacturers listed are permitted, the embedment depth indicated on the Drawings is based on "Pure 110+ by DeWalt" ESR 3298 issued 7/2017. If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.

b. Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer's standard embedment (expansion or mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod according to the manufacturer (adhesive anchors).

c. The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long term temperature of 110 degrees F, and maximum short term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum or more than the maximum stated in the manufacturer's literature.

C. Structural Anchors:

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Power-Stud+SD1" or "Power-Stud+ SD-2" by DeWalt.

b. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Screw-Bolt+" by DeWalt. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.

c. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by DeWalt.

d. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by DeWalt.

e. Shallow Embedment Internally Threaded Insert (3/4" max embedment): "Mini-Undercut +Anchor" by DeWalt, "HSC-A" by Hilti, Inc. or approved equal.

2. Adhesive Anchors:

a. Adhesive anchors shall be “Epcon C6+ Adhesive Anchoring System” by ITW Redhead, “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET-XP Epoxy Adhesive Anchors” by Simpson Strong-Tie Co., or “Pure 110+ Epoxy Adhesive Anchor System” by DeWalt.

b. Structural adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code.

D. Non-Structural Anchors: In addition to the acceptable non-structural anchors listed below, all structural anchors listed above may also be used as non-structural anchors.

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be “Kwik Bolt 3” by Hilti, Inc., “Power-Stud+ SD1” by DeWalt, “Wedge-All” by Simpson Strong-Tie Co. or “TruBolt” by ITW Redhead.

b. Screw Anchors: Screw anchors shall be “Kwik HUS” by Hilti, Inc., “Screw Bolt+” or 316 Stainless Steel Wedge-Bolt” by DeWalt, “Large Diameter Tapcon (LDT) Anchor” by ITW Redhead, or “Titen HD” by Simpson Strong-Tie Co. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.

c. Sleeve Anchors: Sleeve anchors shall be “HSL Heavy Duty Sleeve Anchors” by Hilti, Inc. “Power-Bolt+” by DeWalt “Dynabolt Sleeve Anchor” by ITW Redhead, or “Sleeve-All” by Simpson Strong-Tie Co.

d. Drop-In Anchors: Drop-in anchors shall be “Drop-In” by Simpson Strong-Tie Co., “HDI Drop-In Anchor” by Hilti, Inc., “Smart DI” by DeWalt or “Multi-Set II Drop-In Anchor” by ITW Redhead.

e. Undercut Anchors: Undercut anchors shall be “HDA Undercut Anchor” by Hilti, Inc., “Atomic Undercut+” by DeWalt or “Torq-Cut” by Simpson Strong-Tie Co.

2. Adhesive Anchors:

a. Adhesive anchors shall be “Epcon A7” or “Epcon C6+ Adhesive Anchoring System” by ITW Redhead, “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET Epoxy Tie High Strength Anchoring Adhesive” or “AT High Strength Anchoring Adhesive” by Simpson Strong-Tie Co., or AC100+ Gold” Adhesive Anchoring System” by DeWalt.

b. Non-structural adhesive anchors systems shall be IBC compliant and capable of resisting short term wind and seismic (Seismic Design Categories A and B) as well as long term and short term sustained static loads in uncracked concrete.

c. Non-structural adhesive anchor embedment depth of the rod shall provide a minimum allowable bond strength that is equal to the allowable yield capacity of the rod unless noted otherwise on the Drawings.

E. Concrete Anchor Rod Materials:

1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.

2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.

3. Nuts, washers, and other hardware shall be of a material to match the anchors.

2.05 WELDS

A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).

B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.

C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.06 WELDED STUD CONNECTORS

A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.07 EYEBOLTS

A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.08 ANTISEIZE LUBRICANT

A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

PART 3 -- EXECUTION

3.01 MEASUREMENTS

A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 ANCHOR INSTALLATION

A. Anchor Rods and Concrete Anchors

1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.

2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.

3. Concrete anchors shall not be used in place of anchor rods without Engineer's approval.

4. All stainless steel threads shall be coated with antiseize lubricant.

B. High Strength Bolts

1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". All bolted joints shall be Type N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

C. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days, have a minimum compressive strength of 2500 psi, and shall be at least 50 degrees F.

2. Concrete anchors designed by the Contractor shall be classified as structural or non-structural based on the requirements indicated above.

3. Concrete Anchor Testing:

a. At all locations where concrete anchors meet the requirements for structural anchors at least 10 percent of all concrete anchors installed shall be proof tested to the value indicated on the Drawings, with a minimum of one tested anchor per anchor group. If no test value is indicated on the Drawings but the installed anchor meets the requirements for structural

anchors, the Contractor shall notify the Engineer to allow verification of whether anchor load proof testing is required.

b. Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Proof testing of anchors shall be in accordance with ASTM E488 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.

c. Where Contract Documents indicate anchorage design to be the Contractor's responsibility and the anchors are considered structural per the above criteria, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the Commonwealth of Virginia. The Contractor's Engineer shall also submit documentation indicating the Contractor's proof testing procedures have been reviewed and the proposed procedures are acceptable. Proof testing procedures shall be in accordance with ASTM E488.

d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.

e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all proof testing, including additional testing required due to previously failed tests.

4. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.

5. All holes shall be drilled in accordance with the manufacturer's instructions except that cored holes shall not be allowed unless specifically approved by the Engineer. If cored holes are allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with the manufacturer's instructions prior to installation of adhesive and threaded rod unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water-saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer. . Injection of adhesive into the hole shall be performed to minimize the formation of air pockets in accordance with the manufacturer's instructions. Wipe rod free from oil that may be present from shipping or handling.

D. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.

2. All stainless steel bolts shall be coated with antiseize lubricant.

3.03 WELDING

A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.04 INSPECTION

A. High strength bolting will be visually inspected in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Rejected bolts shall be either replaced or retightened as required.

B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.05 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

- END OF SECTION -

SECTION 05061

STAINLESS STEEL

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. The Contractor shall furnish, install and erect the stainless steel work as shown on the Contract Drawings and specified herein.

B. Stainless steel work shall be furnished complete with all accessories, mountings and appurtenances of the type of stainless steel and finish as specified or required for a satisfactory installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 05010 – Metal Materials

C. Section 05050 – Metal Fastening

D. Section 05500 – Metal Fabrications

1.03 REFERENCES

A. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

B. ASTM A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

C. ASTM A262 - Practice for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel.

D. ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.

E. ASTM A314 - Stainless and Heat-Resisting Steel Billets and Bars for Forging.

F. ASTM A380 - Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.

G. ASTM A473 - Stainless and Heat-Resisting Steel Forgings.

H. ASTM A666 - Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar.

I. ASTM A774 - Stainless Steel Pipe Fittings

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J. ASTM A778 - Stainless Steel Pipe

K. ASTM F593 - Stainless Steel Bolts, Hex Cap Screws and Studs.

L. ASTM F594 - Stainless Steel Nuts.

M. ANSI/ASME B1.1 - Unified Inch Screw Thread (UN and UNR Thread Form).

1.04 TESTS

A. All stainless steel materials including stainless test welds, shall be checked for compliance with tests for susceptibility to intergranular attack. Such tests shall be Practices A, B and E of ASTM A262. Detailed procedures for the tests shall be submitted to the Engineer for approval prior to start of work. Practice A shall be used only for acceptance of materials but not for rejection of materials, and shall be used for screening material intended for testing in Practice B and Practice E. The maximum acceptable corrosion rate under Practice B shall be 0.004 inch per month, rounded off to the third decimal place. If the certified mill report indicates that such test has been satisfactory performed, the fabricator may not be required to repeat the test. Material passing Practice E shall be acceptable.

B. Sample selection for the susceptibility to intergranular attack tests shall be as follows:

1. One (1) sample per heat treatment lot for plates and forgings;

2. One (1) sample per each Welding Procedure Qualification regardless of the joint design;

3. If tests indicate a reduction in corrosion resistance, welding procedure shall be adjusted or heat treatment determined as needed to restore required corrosion resistance.

4. The samples so chosen shall have received all the post-weld heat treatments identical to the finished part.

1.05 SUBMITTALS

A. The Contractor shall prepare and submit for approval shop drawings for all stainless steel fabrication in accordance with Section 01300, Submittals.

B. Submittals shall include, but not be limited to, the following:

1. Certified test reports for susceptibility to intergranular attack.

2. Affidavit of compliance with type of stainless steel shown on the Contract Drawings or specified herein.

3. Certified weld inspection reports.
4. Cleaning and handling of stainless steel in accordance with Paragraph 3.04,

Cleaning and Handling.

C. Samples of finish, on each type of stainless steel to be furnished, shall be submitted to the Engineer upon request.

1.06 QUALITY ASSURANCE

A. Shop inspections may be made by the Engineer. The Contractor shall give ample notice to the Engineer prior to the beginning of any stainless steel fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the works.

B. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of the Contract Drawings or the Specifications.

C. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship.

1.07 HANDLING, STORAGE AND DELIVERY

A. Mechanical damage (e.g., scratches and gouges) to the stainless steel material shall not be permitted and is cause for rejection. Care shall be taken in the material handling since such mechanical damage will result in the passive oxide film being "punctured" leading to a possible lower resistance to the initiation of corrosion than the surrounding chemically-passivated surface.

B. Stainless steel plates and sheets shall be stored vertically in racks and not be dragged out of the racks or over one another. Racks shall be protected to prevent iron contamination.

C. Heavy stainless steel plates shall be carefully separated and chocked with wooden blocks so that the forks of a fork-lift could be inserted between plates without mechanically damaging the surface.

D. Stainless steel plates and sheets laid out for use shall be off the floor and be divided by wooden planks to prevent surface damage and to facilitate subsequent handling.

E. Plate clamps, if used, shall be used with care as the serrated faces can dig in, indent and gouge the surface.

F. Stainless steel fabrications shall be loaded in such a manner that they may be transported and unloaded without being overstressed, deformed or otherwise damaged.

G. Stainless steel fabrications and packaged materials shall be protected from corrosion and deterioration and shall be stored in a dry area. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with approved effective and durable covers.

H. Stainless steel fabrications shall not be placed in or on a structure in a manner that might cause distortion or damage to the fabrication. The Contractor shall repair or replace damaged stainless steel fabrications or materials as directed by the Engineer.

1.08 FIELD MEASUREMENTS

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.

B. The Contractor shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

PART 2 -- PRODUCTS

2.01 MATERIALS AND FINISHES

A. Stainless steel shall be Type 304 unless it is used for underwater service. Stainless steel for underwater service shall be Type 316. Minimum mechanical finish shall be No. 4 as stated in Table 2 unless otherwise noted on the Contract Drawings.

B. The basic mill forms (sheet, strip, plate and bar) are classified by size as shown on Table 1. Tables 2, 3 and 4 identify finishes and conditions in which sheet, bar and plate are available.

C. Tables 2, 3 and 4 show numbered finishes and conditions for sheet, bar and plate. While there are no specific designations for polished finishes on bar or plate, the sheet finish designations are used to describe the desired effect. This also applies to finishes on ornamental tubing.

D. There are three standard finishes for strip, which are broadly described by the finishing operations employed:

1. No. 1 Strip Finish

   No. 1 strip finish is approximately the same as No. 2D Sheet Finish. It varies in appearance from dull gray matte to a fairly reflective surface, depending largely on alloy composition and amount of cold reduction.

2. No. 2 Strip Finish is approximately the same as a No. 2B sheet finish. It is smoother, more reflective than No. 1, and likewise varies with alloy composition.

3. Bright annealed finish is a highly reflective finish that is retained by final annealing in a controlled atmosphere furnace.

Table 1

Classification of Stainless Steel Product Form

Item	Description	Dimensions		
		Thickness	Width	Diameter or Size
Sheet	Coils and cut length: Mill finishes Nos. 1, 2D and 2B Polished finishes Nos. 3, 4, 6, 7 & 8	 under 3/16" under 3/16"	 24" and over all widths	 -- --
Strip	Cold finished, coils or cut lengths Polished finishes Nos. 3, 4, 6,7 & 8	under 3/16" under 3/16"	under 24" all widths	-- --
Plate	Flat rolled or forged	3/16" and over	over 10"	--
Bar	Hot finished rounds, squares, octagons and hexagons Hot finished flats Cold finished rounds, squares, octagons and hexagons Cold finished flats	-- 1/8" to 8" incl. -- 1/8" to 4-1/2"	-- 1/4" to 10" incl. -- 3/8" to 4-1/2"	1/4" and over -- over 1/8" --
Wire	Cold finishes only: (in coil) Round, square, octagon, hexagon and flat wire	 under 3/16"	 under 3/8"	 --
Pipe & Tubing	Several different classifications, with differing specifications, are available.			
Extrusion	Not considered “standard” shapes. Currently limited in size to approximately 6-1/2" diameter or structurals.			

Table 2

Standard Mechanical Sheet Finishes

Unpolished or Rolled Finishes:		No. 4	A polished surface obtained by finishing with a 120-150 mesh abrasive, following initial grinding with coarser abrasives. This is a general purpose bright finish with a visible "grain" which prevents mirror reflection.
No. 1	A rough dull surface which results from hot rolling to the specified thickness followed by annealing and descaling.		
No. 2D	A dull finish which results from cold rolling followed by annealing and descaling, and may perhaps get a final light roll pass through unpolished rolls. A 2D finish is used where appearance is of no concern.	No. 6	A dull satin finish having lower reflectivity than No. 4 finish. It is produced by Tampico brushing the No. 4 finish in a medium of abrasive and oil. It is used for architectural applications and ornamentation where a high luster is undesirable, and to contrast with brighter finishes.
No. 2B	A bright cold-rolled finish resulting in the same manner as No. 2D finish, except that the annealed and descaled sheet receives a final light roll pass through polished rolls. This is the general purpose cold-rolled finish that can be used as is, or as a preliminary step to polishing.	No. 7	A high reflective finish that is obtained by buffing finely ground surfaces but not to the extent of completely removing the "grit" lines. It is used chiefly for architectural and ornamental purposes.
Polished Finishes:		No. 8	The most reflective surface, which is obtained by polishing with successively finer abrasives and buffing extensively until all grit lines from preliminary grinding operations are removed. It is used for applications such as mirrors and reflectors.
No. 3	An intermediate polish surface obtained by finishing with a 100 grit abrasive. Generally used where a semi-finished polished surface is required. A No. 3 finish usually receives additional polishing during fabrication.		

Table 3

Conditions and Finishes for Bar

Conditions	**Surface Finishes**[1]
Hot worked only	(a) Scale not removed (excluding spot conditioning) (b) Rough turned[2] (c) Pickled or blast cleaned and pickled.
Annealed or otherwise heat treated.	(a) Scale not removed (excluding spot conditioning) (b) Rough turned (c) Pickled or blast cleaned and pickled (d) Cold drawn or cold rolled (e) Centerless ground (f) Polished
Annealed and cold worked to high tensile strength[3]	(d) Cold drawn or cold rolled (e) Centerless ground (f) Polished

1 Surface finishes (b), (e) and (f) are applicable to round bars only.

2 Bars of the 4xx series stainless steels which are highly hardenable, such as Types 414, 420, 420F, 431, 440A, 440B and 440C, are annealed before rough turning. Other hardenable grades, such as Types 403, 410, 416 and 416Se, may also require annealing depending on their composition and size.

3 Produced in Types 302, 303Se, 304 and 316.

Table 4

Conditions and Finishes for Plate

Condition and Finish	Description and Remarks
Hot rolled	Scale not removed. Not heat treated. Plates not recommended for final use in this condition.[4]
Hot rolled, annealed or heat treated	Scale not removed. Use of plates in this condition is generally confined to heat resisting applications. Scale impairs corrosion resistance.[1]
Hot rolled, annealed or heat treated, blast cleaned or pickled	Condition and finish commonly preferred for corrosion resisting and most heat resisting applications.
Hot rolled, annealed, descaled and temper passed	Smoother finish for specialized applications.
Hot rolled, annealed, descaled cold rolled, annealed, descaled, optionally temper passed	Smooth finish with greater freedom from surface imperfection than the above.
Hot rolled, annealed or heat treated, surface cleaned and polished	Polished finishes refer to Table 2.

[4] Surface inspection is not practicable on plates which have not been pickled or otherwise descaled.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Holes for bolts and screws shall be drilled. Fastenings shall be concealed where practicable. Joints exposed to the weather shall be formed to exclude water.

B. As far as practicable, all fabricated units shall be fitted and assembled in the shop, with all cuts and bends made to precision measurements in accordance with details shown on approved shop drawings.

C. Work shall be fabricated so that it is installed in a manner that will provide for expansion and contraction, prevent the shearing of bolts, screws and other fastenings, ensure rigidity, and provide close fitting of sections.

D. All finished and/or machined faces shall be true to line and level. Stainless steel sections shall be well formed to shape and size with sharp lines and angles; curved work shall be sprung evenly to curves.

E. All work shall be fitted together at the shop as far as possible, and delivered complete and ready for erection. Proper care shall be exercised in handling all work so as not to

injure the finished surfaces.

3.02 WELDING

A. Welding shall be done in a manner that will prevent buckling and in accordance with Specification 05050 – Metal Fastening, and as modified hereinafter.

B. All welds exposed in the work shall be ground smooth and finished to match the finish of the adjacent stainless steel surfaces.

C. Select weld rods that provide weld filler metal having corrosion resistant properties as nearly identical or better than the base metal to insure preservation of the corrosion-resistant properties. Provide heat treatment at welds where testing of weld procedure indicates it is required to restore the corrosion resistance.

D. Thermal conductivity of stainless steel is about half that of other steels; and the following methods may be used to accommodate this situation:

1. Use lower weld current setting.

2. Use skip-weld techniques to minimize heat concentration.

3. Use back-up chill bars or other cooling techniques to dissipate heat.

E. Edges of the stainless steel to be welded shall be cleaned of contaminants.

3.03 FASTENERS

A. Stainless steel fasteners shall be used for joining stainless steel work.

B. Stainless steel fasteners shall be made of alloys that are equal to or more corrosion resistant than the materials they join.

3.04 CLEANING AND HANDLING

A. All stainless steel surfaces shall be precleaned, descaled, passivated and inspected before, during and after fabrication in accordance with the applicable sections of ASTM A380 and as detailed in the procedures to be submitted to the Engineer for approval prior to start of work. Degreasing and passivation of stainless steel articles shall be conducted as the last step after fabrication.

B. Measures to protect cleaned surfaces shall be taken as soon as final cleaning is completed and shall be maintained during all subsequent handling, storage and shipping.

1. The Contractor shall submit for approval specific procedures listing all the steps to be followed in detecting contamination and in descaling, cleaning, passivation and protecting of all stainless steel.

2. Area showing clear indications of contamination shall be recleaned, repassivated

and reinspected.

C. At approved stages in the shop operations, contaminants such as scale, embedded iron, rust, dirts, oil, grease and any other foreign matter shall be removed from the metal, as directed or approved by the Engineer. The adequacy of these operations shall be checked by the Engineer. Operations in the shop shall be conducted so as to avoid contamination of the stainless steel and to keep the metal surfaces free from dirt and foreign matter.

D. In order to prevent incipient corrosion during fabrication, special efforts shall be made at all times to keep all stainless steel surfaces from coming in contact with other metals.

1. Stainless steel and stainless steel welds shall be cleaned with clean sand free of iron, stainless steel wool, stainless steel brushes, or other approved means and shall be protected at all times from contamination by any materials, including carbon steel, that shall impair its resistance to corrosion.

2. Approved methods of cutting, grinding and handling shall be used to prevent contamination. If air-arc, or carbon-arc cutting is used, additional metal shall be removed by approved mechanical means so as to provide clean, weldable edges. All grinding of stainless steel shall be performed with aluminum oxide or silicon carbide grinding wheels bonded with resin or rubber. Grinding wheels used on carbon steel shall not be used on stainless steel.

3. Sand, grinding wheels, brushes and other materials used for cleaning stainless steel shall be checked periodically by the Engineer for contaminants. Cleaning aids found to contain contaminants shall not be used on the work.

3.05 INSTALLATION

A. All stainless steel fabrications shall be erected square, plumb and true, accurately fitted, adequately anchored in place, set at proper elevations and positions.

B. All inserts, anchor rods and all other miscellaneous work specified in the Detailed Specifications or shown on the Contract Drawings or required for the proper completion of the work, which are embedded in concrete, shall be properly set and securely held in position in the forms before the concrete is placed.

C. All stainless steel fabrications shall be installed in conformance with details shown on the Contract Drawings or on the approved shop drawings.

-END OF SECTION -

SECTION 05120

STRUCTURAL STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.

1. Virginia Uniform Statewide Building Code

2. AISC - "Code of Standard Practice."

3. AISC - "Specification for Structural Steel Buildings".

4. AISC 348 - "The 2009 RCSC Specification for Structural Joints".

5. AWS - "Structural Welding Code".

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Certified Mill Test Reports

2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:

a. Layout drawings indicating all structural shapes, sizes, and dimensions.

b. Beam and column schedules.

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c. Detailed drawings indicating jointing, anchoring and connection details and vent and drain holes where required.

1.05 QUALITY ASSURANCE

A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

B. The erector shall be a qualified installer who participates in the AISC Certification program and is designated an AISC Certified Erector, Category ACSE.

C. The fabricator shall be a qualified fabricator who participates in the AISC Certification program and is designated an AISC Certified Plant, Category STD**.**

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Structural Steel

1. Structural steel for W shapes shall conform to ASTM A992 unless otherwise indicated.

2. Structural steel for HP shapes shall conform to ASTM A572 Grade 50 unless otherwise indicated.

3. Structural steel for S, M, C, and MC shapes and angles and plates shall conform to ASTM A36 unless otherwise indicated.

4. Steel pipe shall be ASTM A53, Grade B.

5. HSS shall be ASTM A500, Grade C or ASTM A1085. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.

6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Contractor, all at the expense of the Contractor.

7. Fasteners for structural steel shall be in accordance with Section 05050, Metal Fastening.

B. Welds

1. Electrodes for welding shall be in accordance with Section 05050, Metal Fastening.

PART 3 -- EXECUTION

3.01 MEASUREMENT

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

A. Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.

B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.

C. All holes in structural steel members required for anchors, anchor rods, bolts, sag rods, vent and drain holes or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.

D. All materials shall be properly worked and match-marked for field assembly.

E. Where galvanizing of structural steel is required, it shall be done in accordance with Section 05035, Galvanizing.

3.03 DELIVERY, STORAGE AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.

C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.

D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.

E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.

F. All bolted connections shall use high strength bolts in accordance with Section 05050, Metal Fastening. High strength bolts shall be installed in accordance with AISC 348 “The 2009 RCSC Specification for Structural Joints”. Bolts specified or noted on the Drawings to be a tension or slip critical “SC” type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.

G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

3. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.

2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.

4. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

A. Painting shall be performed according to Section 09900, Painting and the following additional requirements.

1. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.

2. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

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SECTION 05515

LADDERS

PART 1 -- GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all ladders in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.

1. Virginia Uniform Statewide Building Code
2. ACI 318-Building Code Requirements for Structural Concrete
3. Aluminum Association Specifications for Aluminum Structures
4. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all metalwork specified herein.
2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for ladders shall conform to Section 05010, Metal Materials, unless noted otherwise.

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2.02 METAL FASTENING

A. All welds and fasteners used for ladders shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 LADDERS

A. Ladders shall be furnished with all mounting brackets, baseplates, fasteners, and necessary appurtenances for a complete and rigid installation.

B. All ladders shall be aluminum alloy 6061-T6 or 6063-T5, with a clear, anodized finish, Aluminum Association M12C22A41.

C. All ladders shall conform to dimensions indicated on the Drawings and shall comply with OSHA requirements.

D. Side rails shall be 1-1/2 inch diameter Schedule 80 pipe, minimum.

E. Rungs shall be serrated 3/4 inch diameter, minimum.

F. All exposed connections shall be welded and ground smooth.

G. Ladders shall be as manufactured by Thompson Fabricating Company, or equal.

2.04 LADDER SAFETY SYSTEM

A. All ladders with an uninterrupted length exceeding 20 ft. between landings or floors shall be installed with a ladder safety system.

B. Ladder safety system shall comply with OSHA requirements and meet ANSI A14.3 requirements.

C. Ladder safety system shall include all necessary components to provide a fully operational system, including one full body safety harness with a 310 lb. weight capacity for each ladder safety system.

D. Ladder Safety Systems shall be Miller Vi-Go by Honeywell, LAD_SAF by DBI Sala, or approved equal.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in accordance with Section 09900, Painting.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. Metalwork shall be field painted when specified in accordance with Section 09900, Painting.

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SECTION 05520

HANDRAILS AND RAILINGS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all handrails and railings in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2. ACI 318-Building Code Requirements for Structural Concrete

3. Aluminum Association Specifications for Aluminum Structures

4. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all metal work specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

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A. Metal materials used for handrails and railings shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used in handrails and railings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 HANDRAILS AND RAILINGS

A. General - Handrail systems shall consist of all railings, posts, toeboards, baseplates, anchors, and accessories required for a complete and rigid installation.

1. All handrail systems shall be fabricated from extruded aluminum alloy 6061-T6 or 6105-T5, with Aluminum Association M12C22A41 finish, unless otherwise noted.

2. Metal railings shall be fabricated from 1-1/2 inch Schedule 40 pipe. Metal railing support posts shall be fabricated from 1-1/2 inch Schedule 80 pipe.

3. The centerline of the top guard rail shall be 42 inches above the walking surface for level rail. For stair rail, the centerline of the top guard rail shall be 42 inches above the leading edge of the tread nosing. Stair handrail shall be 34 inches above the leading edge of the tread nosing.

4. Posts

a. Maximum horizontal spacing between posts for level rail shall be six feet.

b. Maximum horizontal spacing between posts for stair rail shall be five feet.

5. All rail joints shall be finished flush and shall occur only at supports. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.

6. Toeboards

a. Toeboards shall project 4-inches above the walking surface and shall not infringe on the minimum required walkway width.

b. Aluminum toeboards shall be extruded from aluminum alloy 6063-T6 unless otherwise noted.

c. Toeboards shall have a minimum thickness of 1/8" at any point. Geometry of toeboard shall closely resemble geometry shown on Drawings.

7. Expansion joint splices shall be provided at 30 foot maximum spacing and at all expansion joints in the structure supporting the handrail.

8. The handrail system shall be designed to resist the design loads specified by both OSHA and the Virginia Uniform Statewide Building Code.

9. Provide handrail extensions at top and bottom of stairs and ramps in accordance with the Virginia Uniform Statewide Building Code.

B. For metal handrail, the Contractor shall have the option of providing a handrail system of either an all welded type construction or a component type construction.

   1. With both the all welded or component type construction, the baseplates and toeboards shall be furnished as shown on the Drawings.

   2. Component Type System

      a. All fittings and brackets shall be designed for stainless steel concealed set screws with internal tyne type connectors.

      b. Exposed fittings shall be cast or extruded aluminum, or stainless steel to match ladder material, except where corrosion-resistant steel is employed as a standard fabricator's item for use.

      c. Component type handrail shall be as manufactured by Thompson Fabricating Company, Inc., or Hollaender Manufacturing Company, Inc.

   3. Welded handrail may be field assembled using component type fittings as described herein.

C. Handrail shall be either Type I or Type II handrail as shown on the Drawings. If no type is indicated on Drawings, handrail shall be Type I.

   1. Type I handrail shall be a two-rail system. The centerline of the intermediate rail shall be 21 inches above the walking surface.

   2. Type II handrail shall be a three-rail system with vertical posts spanning between the two intermediate rails.

      a. The centerline of the lower intermediate rail shall be 7 inches above the walking surface.

      b. The centerline of the upper intermediate rail shall be 5-3/4" below the centerline of the top rail.

      c. Vertical posts spanning between the intermediate rails shall be 1/2" diameter schedule 40 pipe or fiberglass rod.

      d. Spacing of vertical posts shall be as required to prevent passage of a 4-inch sphere at any point.

D. Where gates are required in handrails as shown on the Drawings, they shall be self-closing and shall be provided by the same manufacturer as the handrail. Gates shall swing away from the opening being protected by the handrail.

E. Where safety chains are required in handrails as shown on the Drawings, chains shall be constructed of Type 304 stainless steel. Chains shall be straight link style, 3/16-inch diameter, with at least twelve links per foot, and with snap hooks on each end. Snap hooks shall be boat type and eye bolts for attachment of chains shall be 3/8-inch bolts with 3/4-inch eye diameter welded to the railing posts. Two (2) chains, four inches longer than the anchorage spacing shall be supplied for each guarded area.

2.04 FREE STANDING RAILING SYSTEM

A. Free standing railing system shall be installed on roof ledges where accessible equipment is provided on roof and roof does not have a perimeter parapet wall of a minimum height of 42 inches. Free standing railing system shall be Safety Rail 2000 Guardrail System by BlueWater Mfg., Inc. or approved equal.

B. Toe Board brackets shall be used when the parapet wall is less than 3-1/2” in height.

C. Performance Characteristics: Shall meet and exceed OSHA (Standards - 29 CFR) 1926.502 (b).

1. Railing System shall be designed to withstand a minimum 200 pounds of test load in any direction.

2. Railing System shall consist of a top rail and rail at mid height between top rail and walking surface.

3. Railing system shall extend to a height of at least 42" from the finished roof deck.

4. Railing system shall be free of sharp edges and snag points.

D. Railing and Base

1. Rail shall be 1 5/8” O.D. Hot Rolled Pickled Electric Weld Tubing

2. Each support post shall have a free standing base cast from Class 30 Gray Iron material.

3. Each base shall have four (4) receiver posts for accepting the rails.

4. The receiver posts shall have a positive locking system. A friction locking system will not be acceptable.

5. The receiver posts shall have a slot to enable the rails to be mounted in any direction.

E. Hardware

1. The securing pins shall be made from 1010 carbon steel. The pins shall be zinc plated and yellow chromate dipped. The pins shall consist of a collared pin and a lanyard that connects to a lynch pin.

2. For Gate Assemblies Only. Bolts and washers shall be 3/8" x 3 ½" and 3/8" x 3" grade 5, zinc plated.

3. Finish: Rails: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

   Bases: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. Concrete anchors and bolts for attachment of handrail baseplates to supporting members shall conform to Section 05050, Metal Fastening.

G. All fabricated items shall be shop painted in accordance with Section 09900, Painting.

3.02 INSTALLATION

A. Assembly and installation of handrails and railings shall be performed in strict accordance with manufacturer's recommendations.

B. All handrails and railings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -

SECTION 05531

GRATINGS, ACCESS HATCHES, AND ACCESS DOORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all gratings, floor plates, and hatches in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2. Aluminum Association Specifications for Aluminum Structures

3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection Drawings of all gratings, access hatches, and access doors specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

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PART 2 -- PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for gratings, floor plates, and hatches shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for gratings, floor plates, and hatches shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 GRATING

A. General - Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.

1. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.

2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No fasteners shall be permitted to project above the walking surface.

3. Grating shall be designed for a loading of 150 psf unless otherwise required by the Drawings. Grating deflection shall not exceed 1/4 inch under a uniform load of 100 psf. Minimum grating depth shall be 1-1/2 inches, unless structural requirements based on clear span require more depth.

4. Grating installed in cast-in-place concrete shall be provided with embedded support frames on all perimeter and bearing edges. Support frames shall include anchor straps or headed studs at a maximum of 18” on-center, a minimum of two each side. Support frames shall be fabricated from the same material as the grating.

B. Aluminum Grating

1. Aluminum grating shall be of I-bar type and shall consist of extruded bearing bars positioned and locked by crossbars. All supports, cross members, etc. shall be aluminum. Plank clips for grating holddowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.

2. Grating shall be “19-SI-4 I-Bar Swage Locked” by Alabama Metal Industries Corporation (AMICO), “IB” by Harsco Industrial IKG, “I-Bar 19SGI4", by Ohio Grating Inc., or “I-Bar” by Thompson Fabricating LLC.

2.04 ACCESS DOORS

A. General

1. Door opening sizes, number and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings shall indicate the clear opening dimensions.

2. All doors shall be aluminum unless otherwise noted.

3. Openings larger than 42 inches in either direction shall have double leaf doors.

4. Doors shall be designed for flush mounting and for easy opening from both inside and outside.

5. All doors shall be provided with an automatic hold-open arm with release handle.

6. Double leaf doors shall be provided with safety bars to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.

7. All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be stainless steel.

8. All doors shall be watertight with a continuous gasket. All single door applications shall include a continuous EPDM odor reduction gasket.

9. Door frames shall be extruded and equipped with a 1-1/2 inch minimum drain pipe located by the manufacturer. The drain pipe shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.

B. Wet Well Access Doors

1. Door leaves shall be 1/4 inch, minimum, diamond pattern plate with an approved raised pattern, non-skid surface. Plate shall be stiffened as required to maintain allowable stress and deflection requirements. Stiffeners shall consist of angles or bars welded to the bottom of plate.

2. Doors shall be designed for a 300 psf live load minimum, unless noted otherwise.

3. Doors shall be designed for flush mounting and for easy opening from both inside and outside.

4. All doors shall have an enclosed compression spring assist and open to 90 degrees.

5. Exterior doors shall be Type "J-AL" or "JD-AL", by Bilco Company, Type ”W1S” or “W2S” by Halliday Products Inc., Type "TPS" or "TPD", by U.S.F. Fabrication Inc., Type "THG" or "THG-D", by Thompson Fabricating LLC.

6. Interior doors shall be Type "K" or "KD", by Bilco Company, Type ”S1S” or “S2S” by Halliday Products Inc., Type "APS300" or "APD300", by U.S.F. Fabrication Inc., Type "TH" or "TH-D", by Thompson Fabricating LLC.

7. Doors rated for H-20 traffic loading shall be “JAL-HD” or “JDAL-HD” by the Bilco Company, Type “H1C” or “H2C” by Halliday Products, Inc., or Type “THS” or “THD” by U.S.F. Fabrication Inc.

2.05 FALL THROUGH PREVENTION SYSTEM

A. All access hatches and access doors covering openings measuring 12 inches or more in its least dimension through which persons may fall shall be equipped with a fall through prevention system, except where noted on the Contract Drawings. Access hatches and access doors shall be provided with a permanent installed fall through prevention grate system that provides continuous safety assurance in both its closed and open positions. The grate system shall be made with 6061-T6 aluminum or FRP and be designed for a 300 psf minimum liveload, unless noted otherwise.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All gratings, access hatches, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions. Embedded support frames shall be set level and square.

C. Grating shall not be field cut or modified unless approved by Engineer.

D. Grating shall not be used for equipment support or anchorage.

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SECTION 05540

CASTINGS

PART 1 -- GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all castings in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02604 – Utility Structures

B. Section 05010 - Metal Materials

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all castings specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for castings shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for castings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

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2.03 IRON CASTINGS

A. General - Iron Castings shall include, but not be limited to frames, covers, and grates for trench drains, catch basins, and inlets.

1. Castings shall be of gray iron of uniform quality, free from defects, smooth and well cleaned by shotblasting.

2. Catalog numbers on the Drawings are provided only to show required types and configuration. All covers shall be cast with raised letters as designated on the Drawings.

3. Castings shall be as manufactured by Dewey Brothers, or Neenah Foundry Company.

B. Covers and Grates

1. Covers and grates shall be provided with matching frames. Cover shall fit flush with the surrounding finished surface. The cover shall not rock or rattle when loading is applied.

2. Round covers and frames shall have machined bearing surfaces.

3. Design loadings:

a. Where located within a structure, a minimum design loading of 300 psf shall be used, unless noted otherwise.

b. At all locations not within a structure, the design loading shall be a standard AASHTO H-20 truck loading, unless otherwise noted.

C. Watertight gasketing, bolting, locking devices, patterns, lettering, pickholes, vents, or self-sealing features shall be as detailed on the Drawings.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All castings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

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SECTION 05830

BEARING DEVICES AND ANCHORING

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. The Contractor shall furnish and install bearing plates, pads, expansion devices, anchor rods and bolts and/or other devices used in conjunction with bearings and anchoring of bearing devices and assemblies at supports in accordance with this item and in conformity with the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05035 – Galvanizing

C. Section 05050 – Metal Fastening

D. Section 09900 – Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified hereunder shall conform to the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

1.	RMA Rubber Handbook	A4-F3-T.063-B2, Grade 2, Method B
2.	ASTM A240,	Standard Specification for Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plate and Sheet
3.	ASTM A480	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
4.	ASTM D395, Method B	Standard Test for Rubber Property – Compression Set
5.	ASTM D412	Standard Test for Rubber Properties In Tension
6.	ASTM D471	Standard Test for Rubber Property – Effect of Liquids

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7.	ASTM D573	Standard Test for Rubber-Deterioration In Air Oven
8.	ASTM D575, Method A	Standard Test for Rubber Properties In Compression
9.	ASTM D624, Die C	Standard Test for Rubber Property - Tear Resistance
10.	ASTM D746	Standard Test for Brittleness Temperature of Plastics and Elastomers by Impact
11.	ASTM D792	Standard Test for Specific Gravity and Density of Plastics by Displacement
12.	ASTM D1149	Standard Test for Rubber Deterioration - Surface Ozone Cracking In a Chamber (Flat Specimens)
13.	ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40
14.	ASTM D2240	Standard Test for Rubber Property - Durometer Hardness
15.	ASTM D2256	Standard Test for Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method
16.	ASTM D4894	Standard Specification for PTFE Granular Molding and RPM Extension Materials
17.	ASTM D4895	Standard Specification for PTFE Resin Produced From Dispersion

1.04 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01300, Submittals:

1. Certification of compliance that the materials furnished under this section meet and conform to the property and physical requirements, including all testing, as stated herein and as referenced. Specifically, the certification shall state compliance with the applicable standards (ASTM, ANSI, etc.) for fabrication and testing.

2. Shop Drawings for all materials, including installation and adjustment instructions. Included with the Shop Drawings shall be all material certifications, mill test results, working drawings, etc., which are required by this and other applicable sections of the Specifications.

PART 2 -- PRODUCTS

2.01 ELASTOMERIC BEARING PADS

A. The elastomer portion of pads shall be new neoprene compound. Pads shall be cast under heat and pressure and may be individually molded or cut from pressure-cast stock. Variations from the dimensions shown on the Drawings shall not be more than the following: thickness, ±1/16 inch; width, -1/8 to +1/4 inch; length, -1/8 to +1/4 inch. Tolerances, dimensions, finish and appearance, flash, and rubber-to-metal bonding shall conform to the requirements of A 4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be furnished in one piece and shall not be laminated unless otherwise specified. Pads shall be furnished in identifiable packages.

B. Adhesive for use with elastomer pads shall be an epoxy-resin compound compatible with the elastomer having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikodur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

C. Laminated pads shall consist of alternate laminations of elastomer and hot-rolled steel sheets molded together as a unit. Outer metal laminations shall be 3/16 inch, and inner laminations shall be 14 gage. Outer laminations of elastomer shall be 1/4 inch, and inner laminations shall be of equal thickness (at least 3/8 but not more than 1/2 inch), depending on the number of laminations and thickness of the pad. Edges of metal laminations shall have a cover of approximately 1/8 inch of elastomer. The top and bottom bearing surfaces shall each have an integral sealing rib approximately 1/8 inch in depth, in addition to the specified total thickness, and 3/16 inch in width around their peripheries. The bond between the elastomer and metal shall be such that failure shall occur in the elastomer and not between the elastomer and steel when tested for separation. Variations from specified dimensions for individual laminations shall not be more than those specified herein. The total thickness of the complete pad shall not vary more than ±1/8 inch.

D. Material having a nominal durometer hardness of 70 and 50 shall be used for nonlaminated pads and laminated pads, respectively. Test samples will be prepared from finished pads. Samples of each thickness will be taken from 2 full-size pads from each shipment of 300 pads or less, with 1 additional pad for each additional increment of 300 pads or fraction thereof. When tested using the ASTM methods designated, samples shall comply with the following physical requirements.

1. **Original Physical Properties:** Test results for tear resistance, tensile strength, and ultimate elongation shall not be more than 10 percent below the following specified value:

	Nominal Hardness 50	**Nominal Hardness 70**
Min. tear resistance, ASTM D624, Die C (lb/in of thickness)	180	200

Hardness, ASTM D2240 (points)	50±5	70±5
Min. tensile strength, ASTM D412 (average psi of longitudinal and transverse)	2,500	2,500
Min. ultimate elongation (%)	400	300

The compressive deflection tested in accordance with ASTM D575, Method A, shall be as follows:

a. **Laminated Pads:** The maximum compression deflection shall be 5 and 7 percent of the total rubber thickness at loads of 500 and 800 pounds per square inch, respectively. The maximum shear resistance shall be 50 pounds per square inch of the plan area at 25 percent shear deformation at –20°F. Test pads shall be subjected to a compressive load of 1.5 times the maximum design load without visible damage to the bearing.

b. **Nonlaminated Pads:** When loaded within 300 to 800 pounds per square inch, material shall show a compressive deflection within 20 percent of that given in the charts of Method A, interpolating for actual measured hardness.

2. **Changes in Original Physical Properties:** When pads are oven aged 70 hours at 212°F in accordance with ASTM D573, changes shall not be more than the following:

Property	**Value**
Hardness (points change)	0 to +15
Tensile strength (% change)	±15
Ultimate elongation (% change)	-40

3. **Extreme Temperature Characteristics:** Compression set under constant deflection, ASTM D395, Method B, 22 hours at 212°F, shall not be more than 35 percent. With the low-temperature brittleness test, ASTM D746, breaks shall not occur above –20°F.

4. **Ozone Cracking Resistance:** Upon exposure to 100 parts per million of ozone in air by volume at a strain of 20 percent and a temperature of 100±2°F in a test otherwise in accordance with ASTM D1149, cracks shall not develop within 100 hours. Samples shall be wiped with solvent before the test to remove traces of surface impurities.

5. **Oil Swell:** The volume change shall not be more than +120 percent when tested in accordance with ASTM D471 with ASTM Oil No. 3, 70 hours at 212°F.

2.02 ANCHOR RODS

A. Anchor bolts shall be as specified in Section 05050, Metal Fastening.

2.03 PIPE SLEEVES AND COLLARS

A. Pipe sleeves and collars shall be cut from schedule 40 PVC plastic pipe meeting the requirements of ASTM D1785 unless otherwise noted on the Drawings.

PART 3 -- EXECUTION

3.01 STEEL PLATES, SHAPES, AND BARS

A. Unless galvanizing is indicated on the Drawings, items shall be painted in accordance with the Drawings and Section 09900, Painting.

B. If galvanizing is indicated on the Drawings, steel bearing assemblies for both structural steel beams and girders and prestressed concrete members shall be galvanized as specified in Section 05035, Galvanizing. Except for attachments of bearing plates to beams, all fabrication and welding of bearing plate assemblies shall be performed before the steel is galvanized. All joints of welded parts shall be sealed with weld material. Welds made for attaching bearing plates to beams or girders shall be cleaned and given 2 coats of zinc rich paint having a minimum total coating thickness of 3 mils.

3.02 BRONZE PLATES

A. Sliding surfaces of bronze plates shall be polished.

3.03 COPPER-ALLOY PLATES

A. Finishing of rolled copper-alloy plates will not be required provided their surfaces are plane, true, and smooth.

3.04 SELF-LUBRICATING PLATES

A. Plates shall be fabricated from cast bronze or rolled copper alloy.

B. Sliding surfaces of plates shall be provided with annular grooves or cylindrical recesses or a combination thereof, which shall be filled with a lubricating compound. The lubricating compound shall be compressed into recesses under sufficient pressure to form a nonplastic lubricating inset. The inset shall comprise at least 25 percent of the total area of the plate. The frictional coefficient shall not be more than 0.10. The compound shall be free from material that will cause abrasive or corrosive action on metal surfaces and able to withstand extremely high pressures and atmospheric elements over long periods of time.

C. Items shall be the standard products of the manufacturer of such materials for the application.

D. Prior to assembly, the steel surface that will bear on the self-lubricating bearing plate shall be thoroughly lubricated with additional antioxidant lubricant furnished by the manufacturer. Coatings shall be removed before application of antioxidant lubricant.

3.05 ELASTOMERIC PADS

A. Care shall be taken in fabricating pads and related metal parts so that effects detrimental to their proper performance, such as uneven bearing and excessive bulging, will not occur.

3.06 PLACEMENT OF BEARING PLATES AND PADS

A. Bearing areas shall be finished to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area.

B. Bearing plates or pads shall be set level in exact position and shall have a uniform bearing over the entire area. Provision shall be made to keep plates or pads in the correct position during erection of beams or placement of concrete.

C. Elastomeric pads and other flexible bearing materials shall be placed directly on masonry surfaces finished to a roughness equivalent to that of a No. 36 to No. 46 grit. Pads, bearing areas, or bridge seats and metal bearing plates shall be thoroughly cleaned and free from oil, grease, and other foreign materials. Metal bearing plates or bottoms of prefabricated beams that are to bear on elastomeric pads shall be coated with epoxy and then surfaced with a No. 36 to No. 46 silicon carbide or aluminum oxide grit. Bearing areas shall be finished to equivalent roughness.

D. Metal bearing plates shall be bedded on seats as follows:

1. The seat bearing areas shall be thoroughly swabbed with approved paint, and three layers of duck, 12 to 15 ounce per square yard, shall be placed on it, each layer being thoroughly swabbed with paint on its top surface.

2. Superstructure shoes or pedestals shall be placed in position while paint is plastic. As an alternate to duct and paint, preformed fabric bedding material at least 1/8 inch in thickness may be used when called for on the Drawings or approved in writing by the Engineer.

3.07 PLACEMENT OF ANCHOR RODS

A. All necessary anchor rods and bolts (anchors) shall be accurately set either in the concrete as they are being placed, in formed holes, or in holes cored after the concrete has set. If set in the concrete, the rods and bolts shall be accurately positioned by means of templates and rigidly held in position while the concrete is being placed. Holes may be formed by inserting or casting in the fresh concrete oiled wooden plugs, metal pipe or plastic sleeves, or other approved devices, and withdrawing them after the concrete has partially set or left in place as indicated on the Drawing's or approved by the Engineer. Holes so formed shall be at least 3 inches in diameter or at least 2.5 times the diameter of the rod or bolt. If cored, holes shall be at least 2.5 times the diameter of the anchor used or as indicated on the Drawings. Equipment used for coring concrete shall have been approved by the Engineer. Impact tools will not be permitted.

Reinforcing steel shall be placed to provide adequate space to core rod/bolt holes without cutting the reinforcing steel. For cored holes, anchor rods and bolts shall be adequately held in place at the centroid of the hole or as specified on the Drawings by using approved pre-fabricated equalizers designed to allow grout to penetrate and fill the hole completely and spaced as approved by the Engineer.

B. During freezing conditions, anchor holes shall be protected from water accumulations at all times.

C. Anchors which are to be placed in holes of sufficient and specified diameter after the concrete has set shall be bonded to the concrete with a non-shrink high-strength Portland cement grout in accordance with Section 03600 – Grout or shall be adhesive anchors in accordance with Section 05050 - Metal Fastening. The type anchoring system and grout shall be as indicated on the Drawings. The grout or adhesive shall completely fill the holes. Anchors shall be tested for sufficient pull-out capacity as indicated in applicable sections of the Specifications or as indicated on the Drawings.

D. Anchors that are not designed to project through bearing plates shall be checked for proper projection above the masonry bearing area immediately prior to placement of bearing plates and beams. Nuts on anchor rods at expansion ends shall be adjusted to permit free movement of the span.

E. Angles for anchor assemblies to be attached to sides of concrete beams shall not be installed until beams have received their full dead load and supporting falsework has been removed.

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SECTION 07900

JOINT FILLERS, SEALANTS AND CAULKING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for the complete execution of Work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03250 - Concrete Accessories

B. Section 03290 - Joints in Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C-920 Elastomeric Joint Sealants

2. ASTM D-1056 Flexible Cellular Materials - Sponge or Expanded Rubber

3. SWRI Sealant and Caulking Guide Specification

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, submit the following:

1. Manufacturers literature and installation instructions.

1.05 QUALITY ASSURANCE

A. Applicator shall be a company specializing in the installation of sealants with a minimum of five years experience.

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1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in unopened labeled packages.

B. Store materials in location protected from freezing or damages.

C. Reject and remove from the site materials within broken or damaged packaging.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Sealants

1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C-920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 50% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation, or Sonolastic NP-2, Sonneborn, or DynaTrol II by Pecora Corporation.

2. Type 2: Single component polyurethane sealant meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation, DynaTrol 1-XL by Pecora Corporation, or Sonolastic NP-1 by BASF Construction Chemicals.

3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, Sonolastic Omni Seal by BASF Construction Chemicals.

4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation, Sonolastic Omni Plus by BASF Construction Chemicals.

5. Type 5: Single component, acrylic latex meeting ASTM C-834. AC-20+ Silicone by Pecora Corporation, Sonneborn Sonolac by BASF Construction Chemicals.

6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1657. BC-158 by Pecora Corporation or equal.

7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C-920, Type M, Grade NS, Class 25 such as Deck-O-Seal by W.R. Meadows, Tammsflex by DuraJoint Concrete Accessories, or Synthacalk GC2+ by Pecora Corporation.

8. Type 8: Nonsag, Multi Component, traffic grade polyurethane sealant meeting ASTM C920, Type 19, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation, Sonolastic Ultra by BASF Construction Chemicals.

B. Primer: Non-staining primer recommended by sealant manufacturer for the substrates on this project.

C. Backer Rod: Closed cell foam, nonreactive with caulking materials, non-oily, and approved by the sealant manufacturer. Minimum density shall be 2.00 pounds per cubic foot. Use no asphalt or bitumen-impregnated fiber with sealants.

D. Joint Cleaner: Recommended by sealant or caulking compound manufacturer.

E. Bond breaker: Either polyethylene film or plastic tape as recommended by the sealant manufacturer.

F. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

PART 3 -- EXECUTION

3.01 QUALITY CONTROL

A. Coordinate work with details shown on approved shop drawings prepared by other trades.

B. Verify conditions in the field.

C. Schedule work to follow closely the installation of other trades.

D. Apply sealants and related items in temperatures and dry conditions recommended by the manufacturers.

E. Do not paint sealant, unless recommended by sealant and paint manufacturer.

3.02 PREPARATION

A. Protect finished surfaces adjoining by using masking tape or other suitable materials.

B. Clean and prime joints before starting any caulking or sealing work.

C. Thoroughly clean joints and spaces of mortar and other foreign materials. Cleaning agent shall be Xylol or similar non-contaminating solvent to remove any film from metal surfaces. Masonry or concrete surfaces shall be brushed or air jet cleaned.

D. Joint Requirements

1. All joints and spaces to be sealed in exterior work shall be less than 1/2 inch deep and not less than 1/4 inch wide. If joints in masonry are less than that specified herein, the mortar shall be cut out to the required width and depth. All joints and spaces to receive sealant shall be completely prepared and thoroughly dry before installation of sealant.

2. Unless otherwise specified, joints and spaces which are open to a depth of 1/2 inch or greater shall be solidly filled with back-up material to within 1/4 inch of the surface. Back-up material shall be packed tightly and made continuous throughout the length of the joints. Bond breaker shall be applied as required. If joints are less than 1/4 inch deep, the back-up material may be omitted, a bond breaker substituted and the joint completely filled with sealant. The back-up material shall not project beyond the 1/4 inch depth of the open space in any joint. The following width-to-depth ratio table shall be adhered to, unless otherwise recommended by manufacturer.

	Sealant Depth	
Joint Width	Minimum	Maximum
¼ inch	1/4 inch	1/4 inch
Over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
Over 1/2 inch to 1 inch	1/2 inch	Equal to width
Over 1 inch to 2 inch	1/2 inch	1/2 of width

3.03 APPLICATION

A. Exercise care before, during, and after installation so as not to damage any material by tearing or puncturing. All finished work shall be approved before covering with any other material or construction.

B. Apply sealant by an approved type of gun except where the use of a gun is not practicable, suitable hand tools shall be used. Avoid applying the compound to any surface outside of the joints or spaces to be sealed. Mask areas where required to prevent overlapping of sealant.

C. All joints shall be waterproof and weathertight.

D. Point sealed joints to make a slightly concave joint, the edges of which are flush with the surrounding surfaces. Exposed joints in the interior side of the door and other frames shall be neatly pointed flush or to match adjacent jointing work.

E. Adjacent materials which have been soiled shall be cleaned immediately and the work left in neat and clean condition.

F. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

3.04 ADJUSTMENT AND CLEANING

A. Remove misplaced sealant compounds promptly using methods and materials recommended by the manufacturer, as the work progresses.

B. Allow sealants to cure and remove protective edging, of doors, louvers, saddles windows etc. as directed by the Engineer.

3.05 SCHEDULE

Schedule of Sealants

Application	Sealant	Color
Vertical and horizontal expansion and construction joints in concrete structures unless noted otherwise herein or on Drawings.	Type 1	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by masonry, precast concrete, natural stone or other porous building material, unless noted otherwise herein or on Drawings.	Type 2	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material.	Type 3	To closely match adjacent surfaces and as selected by the Owner.
Sanitary areas, joints in ceramic tile, around plumbing fixtures, countertops, and back splashes.	Type 4	To closely match adjacent surfaces and as selected by the Owner.
Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit.	Type 2 OR Type 3	To closely match adjacent surfaces and as selected by the Owner.
Below thresholds.	Type 6	Manufacturer's standard
Submerged in liquids. See Note 1.	Type 1	Manufacturer's standard
Horizontal Joints exposed to vehicular or pedestrian traffic.	Type 8	To closely match adjacent surfaces.
Other joints indicated on the drawings or customarily sealed but not listed.	Type recommended by manufacturer	To closely match adjacent surfaces and as selected by the Owner.

Note 1. Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

Note 2. Sealants which will come in contact with potable water shall meet the requirements of NSF 61.

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SECTION 09900

PAINTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein.

B. Section Includes:

1. Paint Materials

2. Shop Painting

3. Field Painting

a. Surface Preparation

b. Piping and Equipment Identification

c. Schedule of Colors

d. Work in Confined Spaces

e. OSHA Safety Colors

1.02 RELATED SECTIONS

A. Section 15030 - Piping and Equipment Identification Systems

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications the Work shall conform to the applicable requirements of the following documents:

1. SSPC – The Society for Protective Coatings Standards

a.	SSPC-Vis 1	Pictorial Surface Preparation Standards for Painting Steel Structures
b.	SSPC-SP2	Hand Tool Cleaning
c.	SSPC-SP3	Power Tool Cleaning

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d. SSPC-SP5 White Metal Blast Cleaning

e. SSPC-SP6 Commercial Blast Cleaning

f. SSPC-SP10 Near-White Metal Blast

g. SSPC-SP13/NACE6 Surface Preparation of Concrete

2. NACE - National Association of Corrosion Engineers

3. ASTM D1737 - Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus

4. ASTM B117 - Method of Salt Spray (Fog) Testing

5. ASTM D4060 - Test Method for Abrasion Resistance of Organic Coating by the Taber Abraser

6. ASTM D3359 - Method for Measuring Adhesion by Tape Test

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature and Material Safety Data Sheets for each product.

2. Painting schedule identifying surface preparation and paint systems proposed. Cross-reference with Tables 9-1 and 9-2. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items.

1.05 SYSTEM DESCRIPTION

A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenance.

B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.

C. Paint surfaces which are customarily painted, whether indicated to be painted or not, with painting system applied to similar surfaces, areas and environments, and as approved by Engineer.

D. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

1.06 QUALITY ASSURANCE

A. Painting operations shall be accomplished by skilled craftsman and licensed by the state to perform painting work.

B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.

1.07 STORAGE AND DELIVERY

A. Bring materials to the job site in the original sealed and labeled containers.

B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

PART 2 -- MATERIALS

2.01 GENERAL INFORMATION

A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.

B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared, products were properly applied, and the paint systems were proper for the exposure and service.

C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.

D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.

E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.

F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Tnemec Company Inc.

2. Ameron

3. CARBOLINE

4. Sherwin-Williams

5. International

PART 3 -- EXECUTION

3.01 SHOP PAINTING

A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.

B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints.

3.02 SURFACE PREPARATION

A. General

1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.

2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted prior to cleaning and painting. Reposition items removed upon completion of painting operations.

3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.

4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.

5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch-up coats are in addition to the specified applied systems, and not considered a field coat.

6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.

7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

B. Metal Surface Preparation

1. Conform to current The Society for Protective Coatings Standards (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.

2. Perform blast cleaning operations for metal when following conditions exist:

   a. Moisture is not present on the surface.

b. Relative humidity is below 80%.

c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.

d. Painting or drying of paint is not being performed in the area.

e. Equipment is in good operating condition.

f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.

3. Sandblast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.

4. Sandblast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service.

5. Sandblast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment.

6. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system.

7. Prime cleaned metals immediately after cleaning to prevent rusting.

8. Clean rusted metals down to bright metal by sandblasting and immediately field primed.

C. Concrete Surface Preparation

1. Cure concrete a minimum of 30 days before surface preparation, and painting begins.

2. Test concrete for moisture content, pH and salts using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.

3. Prepare concrete surfaces to receive coatings in accordance with SSPC-13 – Concrete Surface Preparation. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities using blasting or grinding. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall achieve profile as required by manufacturer or where not defined by manufacturer similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or other approved method.

4. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric filler compatible with painting system. Complete fill coats may be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.

5. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.

6. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.

D. Wood

1. Clean wood surfaces free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Remove sap and resin by scraping and wipe clean with rags dampened with mineral spirits.

2. Saturate end grain, cut wood, knots, and pitch pockets with an appropriate sealer before priming.

3. Prime and backprime wood trim before setting in place.

4. After prime coat has dried, fill nailholes, cracks, open joints, and other small holes with approved spackling putty. Lightly sand wood trim prior to applying second coat of paint.

E. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.

2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

F. Masonry

1. Cure for a minimum of 30 days prior to paint application.

2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.

3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

G. Gypsum Drywall

1. Sand joint compound with sandpaper to provide a smooth flat surface. Avoid sanding of adjacent drywall paper.

2. Remove dust, dirt, and other contaminants.

H. Previously-Painted Surfaces

1. Totally remove existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.

2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.

3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.

4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer's recommendations.

5. Check existing paints for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

3.03 APPLICATION OF PAINT

A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.

B. Apply paint without runs, sags, thin spots, or unacceptable marks.

C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.

D. Special attention shall be given to nuts, bolts, edges, angles, flanges, etc., where insufficient film thicknesses are likely. Stripe paint prior to applying prime coat. Stripe painting shall be in addition to coats specified.

E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.

F. Allow paint to dry a minimum of twenty-four hours between application of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined

by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.

G. Suspend painting when any of the following conditions exist:

1. Rainy or excessively damp weather.

2. Relative humidity exceeds 85%.

3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.

4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.

5. Surface temperature of item is within 5 degrees of dewpoint.

6. Dew or moisture condensation are anticipated.

7. Surface temperature exceeds the manufacturer's recommendations.

3.04 INSPECTION

A. Each field coat of paint will be inspected and approved by the Engineer or his authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.

B. Use magnetic dry film thickness gauges and wet fiber thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.

C. Coatings shall pass a holiday detector test.

D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.

E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.

1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.

2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.

F. Paint manufacturer or his representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES

A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.

B. Take all necessary precautions to contain dispersion of sandblasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the sandblasting debris and paint. Suspend painting operations when sanding debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

3.06 PIPING AND EQUIPMENT IDENTIFICATION

A. Piping and equipment identification shall be in accordance with Section 15030, Piping and Equipment Identification Systems.

3.07 SCHEDULE OF COLORS

A. Colors shall be as selected by the Owner. Owner will select color names and numbers from the appropriate color chart issued by the manufacturer of the particular product in question.

3.08 WORK IN CONFINED SPACES

A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or direct air supply to individual

workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosion-proof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state and local regulations at all times.

3.09 OSHA SAFETY COLORS

A. Paint wall around wall-mounted breathing or fire apparatus with the appropriate safety red color; area not exceed 2-feet wide by 3-feet high, unless apparatus covers the area. Fire apparatus include fire hoses, extinguisher, and hydrants.

B. Paint hazardous areas and objects in accordance with OSHA regulations.

TABLE 9-1
PAINTING SCHEDULE

SURFACE	APPLICATION	PAINTING SYSTEM & NO. OF COATS	PRODUCT REFERENCE (TABLE 9.2)	TOTAL MIN. DRY FILM THICKNESS (MILS)
Concrete and Masonry Interior concrete walls and ceilings	All new structures	1 coat sealer 2 coats acrylic epoxy	101 116	75-85 sq.ft./gal. 4-6/coat
Exterior below grade if interior is dry	Accessible areas (e.g. pipe galleries, pump rooms, basements, etc.)	Waterproofing	See Section 07100	
Submerged wastewater	Water retaining side of new wall surfaces where opposite side of wall is interior and dry and where indicated "epoxy waterproofing" on drawing	2 coats high solids epoxy Provide filler as required and recommended by manufacturer	119	6-10/coat
Metals Interior and exterior nonsubmerged (gloss)	All new blowers, pumps, motors and mechanical equipment, piping, etc.	1 coat epoxy polyamide primer 1 coat epoxy polyamide 1 coat aliphatic polyurethane	104 102 115	4-6 4-6 3-5
Interior insulated		1 coat acrylic latex	103	4
Submerged Wastewater		2 coats high solids epoxy	119	8-10/coat
Steel doors, windows and door frames, steel stairs, monorails, structural steel, misc. metals (steel)		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4
Aluminum surfaces in contact with concrete		2 coats coal tar	107	26
Shop Primed Structural Steel	Pre-Engineered Buildings	1 barrier coat 1 coat epoxy 1 coat epoxy	113 114 120	2-3 3-4 3-4
Interior: Tar-dipped piping where color is required		2 coats epoxy resin sealer 2 coats epoxy polyamide	112 102	5-8/coat 5-8/coat
PVC Piping		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4

1. Painting manufacturer shall verify compatibility of containment liner and chemical to be contained. Where incompatible substitute a compatible coating system.

TABLE 9-2

PRODUCT LISTING

REF.	SYSTEM	PURPOSE	PRODUCT			
			Tnemec Series	PPG/AMERON	CARBOLINE	Sherwin-Williams
101	Acrylic filler	Primer-sealer	130-6601	BLOXFIL 4000	Sanitile 100	Cement-Plex 875
102	Epoxy polyamide	Finish coat semi-gloss or gloss	N69	AMERLOCK 2	Carboguard 890	Dura-Plate 235
103	Acrylic latex	Sealer	1028/1029	PITT TECH PLUS	Carbocrylic 3359DTM	DTM Acrylic Primer/Finish
104	Epoxy Polyamide – metal	Primer	66	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
105	Epoxy	Primer/Finish	20	AMERLOCK 2	Carboguard 561/56LT	Macropoxy 646 PW
106	Coal tar epoxy	Finish high-coat build	46H-413	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
107	Coal tar	Sealer	46-465	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
108	Alkyd-medium oil	Finish coat	2H	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
109	Alkyd-long oil	Finish coat	1029	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
110	Epoxy polyamide	Primer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
112	Epoxy polyamide	Sealer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 920 Pre-Prime
113	Urethane	Barrier coat	530	AMERLOCK SEALER	Rustbond	--
114	Polyamine Epoxy	Intermediate coat	27	AMERLOCK 385	Carboguard 893SG	--
115	Aliphatic Polyurethane	Finish coat	1074 or 1075	AMERCOAT 450 H	Carbothane 134HG	Acrolon 218HS
116	Acrylic epoxy	Finish coat	113 or 114	AQUAPON WB	Sanitile 255	Water-Based Catalyzed Epoxy
117	Epoxy block filler	Sealer	1254	AMERLOCK 114	Sanitile 600	Kem Cati-Coat HS Epoxy Filler
118	Catalyzed epoxy	Finish coat	84	AMERLOCK 2/400	Carboguard 890	Macropoxy 646
119	High solids epoxy	Finish coat	104	AMERLOCK 400	Carboguard 890	Dura-Plate 235
120	Epoxy	Top coat	N69	AMERLOCK 2/400	Carboguard 890	--

- END OF SECTION -

SECTION 10523

FIRST AID CABINETS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install first aid cabinets at each pump station and as specified herein. Coordinate work in this Section with painting and marking as specified in Section 09900, Painting. Certain equipment items will be field located by Owner, if not otherwise shown on the Drawings.

1.02 SUBMITTALS

A. Submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified for all items of equipment in this Section in accordance with Section 11000, Equipment General Provisions and Section 01300, Submittals. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.03 MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers' recommendations.

PART 2 -- PRODUCTS

2.01 FIRST AID CABINET

A. The first aid cabinets shall be a Global Industrial First Aid Kit, ANSI Compliant, 10-25 Person, or equal. First aid cabinets shall be provided. Mounting brackets for masonry mounting shall be provided. Cabinets shall be field located as directed by the Engineer.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. First aid cabinets shall be installed as directed by the Engineer. Where required by OSHA regulations, the background of the mounting location shall be painted the appropriate color.

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- END OF SECTION -

SECTION 10800

TOILET AND BATH ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install bath accessories as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 10160 - Metal Toilet Partitions

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's data.

1.04 QUALITY ASSURANCE

A. Coordinate with other work to avoid interference and to assure proper operation and servicing of accessory units.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The following manufacturers are approved for use.

1. American Specialties Inc.

2. Bobrick Washroom Equipment, Inc.

3. Bradley Corp.

4. McKinney Parker

2.02 MATERIALS

A. Provide the following (Model numbers are Bobrick Washroom Equipment, Inc. numbers and are used for convenience only).

062210BR

1. Surface Mounted Paper Towel Dispenser and Disposal: Satin finish stainless steel, 12 gallon removable receptacle. Dispenses 600 C-fold, 800 multifold, or 1100 single fold towels. Model B-3949 with skirt.

2. Surface Mounted Soap Dispenser: 304 stainless steel back and body with satin finish. Capacity of 40 fluid ounces. Corrosion-resistant valve and dispenser. Unbreakable refill window. Vandal resistant. Large, locked, hinged, stainless steel filler top. Model B-2112.

PART 3 -- EXECUTION

3.01 INSPECTION

A. Examine substrates, previously installed inserts and anchorages necessary for mounting of accessories and other conditions under which installation is to occur and notify the Contractor of conditions detrimental to proper completion of work. Do not proceed until unsatisfactory conditions have been corrected in a manner acceptable.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions, using fasteners which are appropriate to substrate and recommended by the manufacturer of the unit. Install plumb and level, firmly anchored in locations indicated.

B. Mounting heights shall comply with the American with Disabilities Act.

3.03 ADJUST AND CLEAN

A. Adjust for proper operation of that mechanisms function smoothly.

B. Clean and polish exposed surfaces after removing protective coating.

- END OF SECTION -

SECTION 11000

EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in acceptable operation all mechanical equipment and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system.

B. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, and other appurtenances as specified, and as may be required for a complete and operating installation.

C. It is the intent of these Specifications that the Contractor shall provide the Owner complete and operational equipment/systems. To this end, it is the responsibility of the Contractor to coordinate all interfaces with related mechanical, structural, electrical, instrumentation and control work and to provide necessary ancillary items such as controls, wiring, etc., to make each piece of equipment operational as intended by the Specifications.

D. The complete installation shall be free from excessive vibration, cavitation, noise, and oil or water leaks.

E. The requirements of this section shall apply to equipment furnished under Divisions 11, 15, and 16.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01090, Reference Standards.

1.03 SHOP DRAWINGS

A. Shop Drawings shall be submitted to the Engineer for all equipment in accordance with Section 01300, Submittals and shall include the following information in addition to the requirements of Section 01300, Submittals:

1. Performance characteristics and descriptive data.

2. Detailed equipment dimensional drawings and setting plans.

3. General lifting, erection, installation, and adjustment instructions, and recommendations.

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4. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.

5. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.

6. Details on materials of construction of all components including applicable ASTM designations.

7. Information on bearing types and bearing life.

8. Gear box design and performance criteria and AGMA service factor.

9. Piping schematics.

10. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at ½, ¾, and full load; slip at full load; running, full load, and locked rotor current values; and safe running time-current curves.

11. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

12. Equipment shop coating systems, interior and exterior.

13. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.

14. A list of spare parts and special tools to be provided.

15. Any additional information required to show conformance with the equipment specifications.

16. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.

1.04 OPERATION AND MAINTENANCE INSTRUCTION/MANUALS

A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01300, Submittals.

B. O&M manuals shall include instructions, equipment ratings, technical bulletins, and any other printed matter such as wiring diagrams and schematics, prints or drawings, containing full information required for the proper operation, maintenance, and repair of

the equipment. Included in this submission shall be a spare parts diagram, complete spare parts list, bill of materials, OEM part numbers and manufacturer's catalog information of all equipment components.

D. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item.

E. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission.

F. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.

G. Extensive pictorial cuts of equipment are required for operator reference in servicing.

H. When written instructions include Shop Drawings and other information previously reviewed by the Engineer, only those editions thereof which were approved by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the instructions.

1.05 GENERAL INFORMATION AND DESCRIPTION

A. All parts of the equipment furnished shall, be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all conditions of operation. All materials shall be new, and both workmanship and materials shall be entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.

B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.

C. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards.

D. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provision shall be made for accessible lubrication by extending lubrication lines and fittings to approximately 30 inches above finished floor elevation.

E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.

G. All machinery and equipment shall be safeguarded in accordance with the safety codes of the USA and the State in which the project is located.

H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with suitable protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.

I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.

J. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

1.06 EQUIPMENT WARRANTIES

A. Warranty requirements may be added to or modified in the individual equipment specifications.

B. The equipment furnished under this Contract shall be guaranteed to be free from defects in workmanship, design and/or materials for a period of one (1) year unless otherwise specified in the individual equipment specifications. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner (substantial completion) with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the operational period after the equipment startup. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

C. The Contractor shall provide an equipment warranty log book prepared specifically for this project and submit two (2) copies of the document to the Engineer prior to final payment. The equipment warranty log book shall include a summary listing of all equipment warranties provided, date received, and start date and end date of warranty period. A copy of each equipment warranty and equipment start-up certification shall also be provided in the document.

D. The Equipment Supplier shall guarantee to the Owner that all equipment offered under these specifications, or that any process resulting from the use of such equipment in the manner stated is not the subject of patent litigation, and that he has not knowingly offered equipment, the installation or use of which is likely to result in a patent controversy, in which the Owner as user is likely to be made the defendant.

Where patent infringements are likely to occur, each Equipment Supplier shall submit, as a part of his bid, license arrangements between himself, or the manufacturer of the equipment offered, and the patent owner or the controller of the patent, which will permit the use in the specified manner of such mechanical equipment as he may be bidding.

Each Equipment Supplier, by submitting his bid, agrees to hold and save the Owner and Engineer or its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the work under this contract, including the use of the same by the Owner.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The materials covered by these Specifications are intended to be equipment of proven reliability, and as manufactured by reputable manufacturers having experience in the production of such equipment. The Contractor shall, upon request of the Engineer, furnish the names of not less than three (3) successful installations of the manufacturer's equipment of the same size and model of that offered under this contract. The equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

2.02 ANCHORS AND SUPPORTS

A. The Contractor shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and suitable templates shall be used by the Contractor when required in the detailed equipment Specifications.

B. Anchor bolts and fasteners shall be furnished in accordance with Section 05050, Metal Fastening, and with the individual equipment Specifications. All anchor bolts shall be a minimum of 1/2-inch diameter. All anchor bolts, handrail bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.

C. The Contractor shall provide all concrete pads or pedestals required for equipment furnished. All concrete equipment pads shall be a minimum of 6” high, unless otherwise shown on the Drawings and shall be doweled.

D. Pipe sleeves or other means of adjusting anchor bolts shall be provided where indicated or required. Equipment shall be leveled by first using sitting nuts on the anchor bolts, and then filling the space between the equipment base and concrete pedestal with non-shrink grout, unless alternate methods are recommended by the manufacturer and are acceptable to the Engineer (such as shim leveling pumps, or chemical grout). Non-shrink grout shall be as specified in Section 03600, Grout.

2.03 STRUCTURAL STEEL

A. All materials shall conform to applicable provisions of the AISC Specifications for the design and fabrication of structural steel, and to pertinent ASTM Standard Specifications.

2.04 DISSIMILAR METALS

A. All dissimilar metals shall be properly isolated to the satisfaction of the Engineer.

2.05 GALVANIZING

A. Where required by the equipment specifications, galvanizing shall be performed. in accordance with Section 05035, Galvanizing.

2.06 STANDARDIZATION OF GREASE FITTINGS

A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be “Zerk” type.

2.07 ELECTRICAL REQUIREMENTS

A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 16 specifications and the latest National Electric Code.

B. In the individual equipment specifications, specified motor horsepower is intended to be the minimum size motor to be provided. If a larger motor is required to meet the specified operating conditions and performance requirements, the Contractor shall furnish the larger sized motor and shall upgrade the electrical service (conduit, wires, starters, etc.) at no additional cost to the Owner.

C. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.08 ACCESSORIES, SPARE PARTS, AND SPECIAL TOOLS

A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications or where recommended by the equipment manufacturer.

B. Spare parts shall be identical and interchangeable with original parts.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Painting requirements for spare parts shall be identical to those for original, installed parts. Where no painting or protective coating is specified, suitable provisions shall be made to protect against corrosion.

E. Spare parts shall be delivered at the same time as the equipment to which they pertain. Spare parts shall be stored separately in a locked area, maintained by the Contractor, and shall be turned over to the Owner in a group prior to substantial completion. All of these materials shall be properly packed, labeled, and stored where directed by the Owner and Engineer.

F. The Contractor shall furnish all special tools necessary to operate, disassemble, service, repair, and adjust the equipment in accordance with the manufacturer's operation and maintenance manual.

G. The Contractor shall furnish a one year supply of all recommended lubricating oils and greases. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required. All of these materials shall be properly packed, labeled and stored where directed by the Engineer.

2.09 EQUIPMENT IDENTIFICATION

A. All mechanical equipment shall be provided with a substantial stainless steel nameplate, mechanically fastened with stainless steel hardware in a conspicuous place, and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

B. Each pump and other piece of mechanical equipment shall also be identified as to name and number by a suitable laminated plastic or stainless steel nameplate mechanically fastened with stainless steel hardware; for example, "Raw Water Pump #1". Coordinate name and number with same on remotely located controls, control panel, and other related equipment.

C. Nameplates shall not be painted over.

PART 3 -- EXECUTION

3.01 SHOP TESTING

A. All equipment shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.

B. No equipment shall be shipped to the project until the Engineer has been furnished a certified copy of test results and has notified the Contractor, in writing, that the results of such tests are acceptable.

C. Certified copies of the manufacturer's actual test data and interpreted results thereof shall be submitted to the Engineer for review in accordance with Section 01300, Submittals.

D. Shop testing of electric motors shall be in accordance with applicable requirements of Section 15170, Electric Motors; and Section 16000, Basic Electrical Requirements.

3.02 STORAGE OF EQUIPMENT AND MATERIALS

A. Contractor shall store his equipment and materials at the job site in strict accordance with the manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations, and rulings of the public authority having jurisdiction. Equipment and materials shall not be delivered to the site prior to 90 days in advance of the scheduled installation. Partial payment requests will not be processed for materials delivered prior to 90 days before installation or for materials that are not properly stored.

B. Material or equipment stored on the job site is stored at the Contractor's risk. Any damage sustained of whatever nature shall be repaired to the Engineer's satisfaction at no expense to the Owner. Stored electrical equipment is to be protected from the elements and shall have space heaters energized.

C. Contractor shall not store unnecessary materials or equipment on the job site and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.

D. Contractor shall observe all regulatory signs for loadings on structures, fire safety, and smoking areas.

E. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

3.03 INSTALLATION

A. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation. Equipment shall be installed strictly in accordance with recommendations of the manufacturer. A copy of all installation instructions shall be furnished the Engineer's field representative one week prior to installation.

B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.

C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.

D. All equipment sections and loose items shall be match-marked prior to shipping.

E. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the manufacturer's qualified mechanic, millwright, or machinist, to align the pump and motor prior to making piping connections or anchoring the pump base. Alignment shall be as specified herein.

F. The Contractor shall furnish oil and grease for initial operation and testing. The manufacturer and grades of oil and grease shall be in accordance with the recommendations of the equipment manufacturer.

3.04 ALIGNMENT

A. Set equipment to dimensions shown on drawings. Dimensions shall be accurate to +/- 1/16 inch unless otherwise noted on the drawings. Wedges shall not be used for leveling, aligning, or supporting equipment.

B. General Equipment Leveling: Non-rotating equipment shall be set level to +/- 1/16 inch per 10 foot length (.005 inch per foot) unless otherwise noted on the drawings. Shims shall be used unless equipment is furnished with leveling feet. Set shims flush with equipment baseplate edges. When grouting is required, equipment shall be shimmed to allow a minimum of one inch grout thickness. Grout shall cover shims at least 3 inches. Final level check shall be held for inspection and approval by Engineer before proceeding.

C. Grouting

1. Fill anchor bolt holes or sleeves with grout, after bolt alignment is proven, and prior to placing grout under equipment bases.

2. Surface Preparation. Roughen surface by chipping, removing laitance, and unsound concrete. Clean area of all foreign material such as oil, grease, and scale. Saturate area with water at least 4 hours prior to grouting, removing excess water ponds.

3. Application. Place grout after the equipment base has been set and its alignment and level have been approved. Form around the base, mix grout, and place in accordance with the grout manufacturers published instructions. Eliminate all air or water pockets beneath the base using a drag chain or rope.

4. Finishing. Point the edges of the grout to form a smooth 45 degree slope.

5. After grout has cured (not before 3 days after placement) paint exposed surfaces of grout with shellac.

6. Level Verification. After grout has cured, and immediately prior to drive alignment, recheck equipment for level and plumb. Re-level and square as necessary. Hold final checks for inspection and approval by Engineer.

D. Inspect for and remove all machining burrs or thread pulls in female holes on mating surfaces of mounting frame and machine feet.

E. Inspect and clean equipment mounting base pads, feet, and frames to remove all grease, rust, paint and dirt.

F. Assembled equipment shafts shall be set level to .0015 inches per foot of shaft length (+/- .0005 inches) up to a maximum of 0.015 inches for any length shaft unless the manufacturers requirements are more stringent or unless otherwise noted in the equipment specifications. Use the machined surfaces on which the equipment sets for the base/mounting frame leveling plane. Use the machined shaft surface for equipment leveling plane.

G. Sprocket and Sheave Alignment. Check shaft mounted components for face runout and eccentricity (outside diameter) runout by magnetically mounting a dial indicator on a stationary base and indicating over 360 degrees on a continuous machined surface at the outside diameter of the component. Maximum allowable total indicated face runout and eccentricity for sprockets and sheaves will be per ANSI Standard B29.1-1975.

H. Belt tensioning. Set drive belt tension to manufacturer's specification for the belt type. Recheck alignment after drive tensioning.

I. Thermal/Mechanical Growth. Thermal/mechanical growth corrections for driver and driven machines will be used in vertical and horizontal alignment where applicable. The equipment manufacturer will determine thermal/mechanical growth applicability for any machine and provide the correction offsets to be used.

J. Rotating Shaft Alignment

1. Fixtures will be set up on the driver and driven machine, machines shaft surfaces. Machined coupling hubs may be used only if there is no clearance to mount fixtures directly on the shafts.

2. Primary alignment method for direct drive machines is when coupled. Uncoupled alignment will be used only when approved by the Engineer.

3. Account for possible coupling flex by always rotating coupled machines in the same direction during alignment.

4. Uncoupled machines must be connected so that both shafts turn together without relative motion during alignment.

5. Indicator bar sag will be measured and included for each reverse indicator alignment setup.

6. Reverse Dial Indicator. The final maximum allowable misalignment: vertical and horizontal from the desired targets of .000 inches (for a non-thermal growth machine) or from the given target readings (for a thermal growth machine) must meet BOTH of the following conditions simultaneously: 1/2 the final total indicator reading at each indicator will be no more than shown in the table below

AND the final remaining correction at each machine foot be no more than .001 inches of required movement.

Machine Speed (RPM)	Total Misalignment* (inches)
Up to 1800	.002
1800 and greater	.001

* 1/2 indicator reading

3.05 FIELD TESTING

A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions. Provide all necessary calibrated instruments to execute performance tests. Submit report certified by the pump manufacturer's representative.

B. Field testing shall be in accordance with section 01650, Start-up and Field Testing.

C. In addition to the above described field tests, any other tests specifically required by Section 11100, Pumps-General, the individual equipment Specifications, or by the manufacturer shall be performed.

D. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.

F. Field testing of electric motors shall be in accordance with Section 15170, Electric Motors; and Section 16000, Basic Electrical Requirements.

3.06 VIBRATION TESTING

A. Unless specified otherwise in the detailed equipment specifications, each pump, blower, compressor, motor or similar item of stationary rotating equipment having a rated power in excess of 40HP shall be tested after installation for acceptable vibration levels.

B. Vibration testing shall be performed by an experienced factory-trained and authorized third-party analysis expert (not a sales representative) retained by the Contractor and approved by the Engineer. Each unit or pump system shall be tested separately without duplicate equipment running. All field testing shall be done in the presence of the Engineer. The Engineer shall be furnished with four (4) certified copies of vibration test data for each test performed.

C. For systems with variable speed drives, tests shall be conducted at various speeds between maximum and minimum. For systems with two-speed drives, tests shall be conducted at both speeds. For systems with constant-speed drive, tests shall be conducted under various loading conditions as determined by the Engineer.

D. All field vibration tests shall be performed with the equipment operating on the product for which it is intended, or a substitute acceptable to the Engineer.

E. The term displacement, as used herein, shall mean total peak-to-peak movement of vibrating equipment, in mils; velocity or speed of the vibration cycle, measured in G's. Displacement and velocity shall be measured by suitable equipment equal to IRD Mechanalysis, Bentley, Nevada.

F. Frequency of vibration, in cycles per minute (cpm), shall be determined when vibration exceeds specified levels or as otherwise necessary. Vibration shall be measured on the bearing housing, unless other locations are deemed necessary by the vibration analysis expert and Engineer.

3.07 PAINTING

A. All surface preparation, shop painting, field repairs, finish painting, and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900, Painting.

B. All shop coatings shall be compatible with proposed field coatings.

C. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.

D. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.08 WELDING

A. The Equipment Manufacturer's shop welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirement of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.

B. The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.

C. The Contractor shall perform all field welding in conformance with the information shown on the Equipment Manufacturer's drawings regarding location, type, size, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society, and special conditions, as shown by notes and details.

- END OF SECTION -

SECTION 11100

PUMPS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.

B. All pumping equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.

D. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.

1.02 SHOP DRAWINGS

A. Shop Drawings shall include the following information in addition to the requirements of Section 01300, Submittals and Section 11000, Equipment General Provisions.

1. Details of shaft sealing system

2. Pump performance curves at rated speed and reduced speed (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, NPSH required, and minimum submergence. Curves shall include limits (minimum and maximum flows) for stable operation without cavitation, overheating, recirculation, or excessive vibration.

3. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, and anchor bolt locations and forces.

4. Submersible pump submittals shall also include:

   a. Product data sheets for power and control cables and length of cables.

   b. Details on pump guide rail system and mounting requirements.

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PART 2 -- PRODUCTS

2.01 MATERIALS

A. All materials employed in the pumping equipment shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.

2. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.

B. Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.

C. Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.02 APPURTENANCES

A. Pressure Gauges

1. The Contractor shall furnish and install pressure gauges on the discharge piping of each wet-pit submersible pump in the locations shown on the Drawings or as directed by the Engineer.

2. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head or to a minimum of 30% above the maximum operation pressure, whichever is greater. Graduation shall be in feet of water.

3. All gauges shall be supplied by one manufacturer and shall be as specified in Section 17650, Pressure Gauges.

4. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 17698, Instrumentation and Control Accessories.

B. Flexible couplings for direct driven pumps shall be as manufactured by Falk, Dodge, Woods Corp., or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.

2.03 ELECTRICAL REQUIREMENTS

A. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Engineer.

B. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.04 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of Section 11000, Equipment General Provisions, nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency at the primary design point.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Drains: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with galvanized steel pipe or copper tube, properly supported with brackets.

B. Solenoid Valves: Where required, the pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

3.02 SHOP TESTING

A. Shop tests shall be performed in accordance with Section 11000, Equipment General Provisions, and except where stated otherwise herein, shall be conducted in accordance with the latest version of Hydraulic Institute Standard 14.6, Hydraulic Performance Acceptance Tests.

C. Certified test curves for shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications.

D. Pumps shall be within the tolerances specified for Acceptance Grade 1U, in accordance with the latest version of Hydraulic Institute Standards 14.6.

E. For submersible pumps all tests shall be run at minimum pump submergence specified in the individual pump specifications.

3.03 FIELD TESTING

A. Field tests shall be performed in accordance with Section 01650, Start-up and Field Testing, and additionally as specified below and in the individual pump specifications.

B. Final acceptance tests shall demonstrate the following:

1. The pumps have been properly installed and are in proper alignment.

2. The pumps operate without overheating or overloading of any parts and without objectionable vibration.

3. The pumps can meet the specified operating conditions. All pumps shall be checked at maximum speed for a minimum of four points on the pump curve for capacity, head, and amperage. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing.

- END OF SECTION -

SECTION 11142

SUBMERSIBLE CHOPPER PUMPS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install submersible chopper pumps and conditioning pumps and appurtenances at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions and Section 11100, Pumps – General.

1.02 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:

1. Copies of certified shop test reports
2. Field test results
3. Certificates of installation
4. Manufacturer's installation instructions
5. Spare Parts List

1.03 WARRANTY AND GUARANTEE

A. Warranty and Guarantee shall be as specified in Section 11000, Equipment General Provisions. The warranty shall be for one (1) year starting at the Substantial Completion.

1.04 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. The submersible chopper pumps shall be specifically designed to pump waste solids at heavy consistencies without plugging or dewatering of the solids. Materials shall be chopped/macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood paper products and stringy materials without plugging, both in tests and field applications.

B. The submersible conditioning pumps shall be specifically designed to pump waste solids at heavy consistencies without plugging or dewatering of the solids.

	Wastewater Pump Penn Ave PS	Wastewater Pump Conway PS	Conditioning Pump Penn Ave PS	Conditioning Pump Conway PS
Number of Units	2	2	1	1
Design Capacity (gpm)	600	870	312	312
Total Dynamic Head (feet)	81	71	16	16
Secondary Design Point Flow (gpm)	300	400	n/a	n/a
Secondary Design Point Head (feet)	55	40	n/a	n/a
Maximum Brake Horsepower	40	40	5	5
Maximum Pump Speed (rpm)	1670	1670	1200	1200
Temperature of Liquid Pumped	Ambient	Ambient	Ambient	Ambient
Suction Condition	Flooded	Flooded	Flooded	Flooded
Minimum Suction Diameter (In.)	6	6	4	4
Minimum Discharge Diameter (In.)	6	6	4	4
Rating	460V, 3 ph, 60 Hz	460V, 3 ph, 60Hz	460V, 3 ph, 60Hz	460V, 3 ph, 60 Hz
Variable Frequency Drive	Yes	Yes	No	No

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Chopper pumps shall be manufactured by Vaughan or equal.

B. Pump Models shall be as follows:

	Conway WWPS	Penn Ave WWPS
Wastewater Pumps	Model S4S-118	Model S4S-118
Conditioning Pump	Model S4KC-089	Model S4KC-089

2.02 MATERIALS

A. The pump and all related equipment shall be designed for the wastewater application specified herein and shall be suitable for continuous or intermittent operation. The pump shall be bottom suction, side discharge construction and shall be supplied with a foot mounted discharge connection elbow and integral sliding rail removal system of the pump manufacturer's design matched to the pumps being supplied.

B. The pumps shall be submersible type and shall be capable of operating in a continuous submerged condition as shown on the Drawings in a wet well installation.

C. The lifting cover, stator housing, and volute casing shall be close grained cast iron conforming to ASTM A48-Class 30, 35, or 40.

D. All exposed nuts, bolts, washers, and other fastening devices shall be AISI type 316 stainless steel.

E. Casing

1. The pump casing shall be of volute design, spiraling outward to the Class 125 flanged centerline discharge.

2. Casing shall include a replaceable Rockwell C 60 alloy steel cutter to cut against the rotating impeller pump-out vanes.

3. Casing shall be ASTM A536 ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics.

F. Impeller

1. Shall be semi-open type with pump out vanes to reduce seal area pressure.

2. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of 0.015" to 0.025".

3. Impeller shall be ASTM A148 alloy steel, case hardened to minimum Rockwell C 60 and dynamically balanced.

4. The impeller shall be keyed to the shaft and shall require no axial adjustments and no set screws.

G. Cutter Bar Plate

1. Shall be recessed into the pump casing and shall contain at least 2 shear bars extending diametrically across entire pump suction opening.

2. Cutter bar shall be plate steel hardened to minimum Rockwell C 60.

3. Pumps with fabricated impeller, cutter bar or casing shall not be acceptable. Add-on cutting mechanisms below the pump inlet shall not be acceptable.

H. Cutter Nut

1. The impeller shall be secured to the shaft using a special cutter nut, designed to cut stringy materials and prevent binding.

2. The cutter nut shall be cast steel hardened to minimum Rockwell C 60.

I. Upper Cutter

1. Shall be threaded into the casing or back pull-out adapter plate behind the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area.

2. Upper cutter shall be cast steel hardened to minimum Rockwell C 60.

3. The ratio of upper cutter cutting diameter to shaft diameter in the upper cutter area of the pump shall be 3.0 or less.

J. External Cutter: Shall cut against the outside surface of the cutter bar. External cutter shall be cast steel, heat treated to minimum Rockwell C 60.

K. Pump Shafting: The pump shaft and impeller shall be supported by ball bearings. Shafting shall be AISI 4140 heat-treated steel, with a minimum diameter of 1.5 inches.

L. Bearing Housing

1. Shall be A536 ductile cast iron and machined with piloted bearing fits for concentricity of all components.

2. Bearing housing shall have oil bath lubrication using ISO Gr. 46 turbine oil and a side mounted site glass to provide a permanently lubricated assembly.

M. Thrust Bearings: Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings with a minimum L-10 rated life of 100,000 hours. Overhang from the centerline of the lower thrust bearing to the seal faces shall be a maximum of 1.7”.

N. Pump Mechanical Seal:

1. Mechanical Seal shall require no seal flush water.

2. The mechanical seal shall be located immediately behind the impeller hub to

maximize the flushing available from the impeller pump-out vanes.

3. The seal shall be a cartridge-type mechanical seal with Viton O-rings and silicon carbide. This cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required from the installer.

4. Any springs used to push the seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a 17-4PH, heat-treated seal sleeve and a ductile cast iron seal gland.

O. Shaft Coupling: The submersible motor shall be close coupled directly to the pump shaft using a solid sleeve coupling keyed to both the pump and motor shafts.

2.03 ACCESSORIES AND OPTIONS

A. External Oil reservoir

1. Oil reservoir shall be of the external/remote type and located at grade with a hose feeding down to the side of bearing housing to detect oil level and shut off the motor in event of low oil level.

2.04 ELECTRICAL AND CONTROL REQUIREMENTS

A. The pump manufacturer shall provide the power and control cables between the pump and the control panel and shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. A quick connect shall be provided and installed in a location accessible from the top to the wet well without requiring personnel entry. No splices shall be allowed unless specifically indicated on the Drawings. Cables shall be PVC or oil resistant chloroprene rubber jacketed type SPC cable suitable for submersible pump applications, shall be sized according to NEC and ICEA standards, and shall meet with MSHA approval. Stainless steel strain relief connectors shall be furnished for all cables.

B. Motor Requirements

Motors	Wastewater Pumps	Conditioning Pump
Horsepower	40	5
Speed, rpm	1670	1200
Explosion Proof	Yes	Yes
Insulation	Class F	Class F
Inverter Duty	Yes	Yes
Service Factor	1.15	1.15
Motor Winding Temperature Switches	Yes	Yes

C. An automatic oil level switch shall be provided to stop the pump in the event of low oil level. A relay shall be included for mounting in the motor control panel. The motor shall include dual moisture sensing probes.

D. The pump motor shall be UL listed Class I Group D Division 1 motor. The stator winding and stator leads shall be moisture resistant. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.

E. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of ten (10) starts per hour without overheating.

F. All motors shall be selected by, and the sole responsibility of, the Pump Manufacturer. All motors shall be housed in enclosures specifically designed for submersible pump application.

G. Each pump motor stator shall incorporate minimum of two thermal switches, imbedded in adjoining phases and connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm.

2.05 GUIDE RAIL SYSTEM

A. The Guide Rail Mounting System shall be as shown on the Contract Drawings and as specified herein.

1. A rail system shall be provided and installed for each pump. The pump shall be easily removed from the wet pit for inspection or service without entering the pit or disconnecting piping.

2. The pump shall be provided with a foot mounted discharge connection elbow constructed of ductile iron, permanently installed in the wet well along with the discharge piping. The discharge connection elbow shall be constructed with a 125 lb. ANSI standard flat faced flange. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection or service. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple downward motion of the pump.

3. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by the guide bar(s) and pressed tightly against the discharge connection elbow to provide positive sealing under all conditions.

4. The entire sliding rail system shall be designed to safely withstand all stresses imposed thereon by vibration, torque, shock and all possible direct and eccentric loads. No portion of the pump shall bear directly on the floor of the sump.

5. Lower guide bar holders shall be integral with the discharge connection. Guide bars shall be of at least standard weight 316 stainless steel pipe of a conservative

size adequate for its intended use. The guide bars shall not support any portion of the weight of the pump.

6. All anchor bolts, lifting bolts, eye lugs and lifting chain, etc. necessary for a complete installation and maintenance of the pump shall be constructed of Type 316 stainless steel and shall be adequately designed for its intended use.

7. All metal to metal interfaces where movement might occur shall be non-sparking. The guide mounting system for the influent pumps shall meet or exceed Underwriters Laboratory requirements for operation in a Class I, Division 1, Group D hazardous location.

2.07 SPARE PARTS

A. Spare parts shall be furnished in accordance with Section 11000, Equipment General Provisions and shall be as recommended by the manufacturer.

B. One (1) spare cutter bar.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions. Field services shall include the following site visits:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Testing	1	1
Startup	1	1
Training	1	1

3.02 SHOP TESTING

A. The pump manufacturer shall perform the following inspections and tests on each pump before shipment from factory:

1. Impeller, motor rating and electrical connections shall be checked.

2. A motor and cable insulation test for moisture content or insulation defect shall be made.

3. Prior to submergence, the pump shall be run non-submerged to establish correct rotation and mechanical integrity.

4. Pump shall demonstrate compliance with the specified performance for flow, head, horsepower, and motor current draw and shall experience a heat rise of not greater

than 45°C (80°F) above ambient temperature. The pump shall operate submerged for minimum of 30 minutes.

5. Provide a 7-point pump curve for each pump. The testing shall be in accordance with the Hydraulic Institute Standards. Test pump curve shall include design point listed in this section and operating points below and above the design points.

6. After operational Test No. 5, the insulation test (No. 2) shall be performed again.

7. Provide standard hydrostatic test of volute for each pump. The testing shall be in accordance with the Hydraulic Institute Standards.

B. Pump manufacturer shall provide a certified written report stating that the foregoing tests have been completed and including results of each test with each pump at the time of shipment.

- END OF SECTION -

SECTION 15000

BASIC MECHANICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.

B. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent Contracts for a complete installation.

C. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, wall sleeves, wall pipes, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.

D. Piping assemblies under 4-inch size shall be generally supported on walls and ceilings, unless otherwise shown on the Drawings or ordered by the Engineer, being kept clear of openings and positioned above "headroom" space. Where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.

E. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.

F. The work shall include, but not be limited to, the following:

1. Connections to existing pipelines.

2. Test excavations necessary to locate or verify existing pipe and appurtenances.

3. Installation of all new pipe and materials required for a complete installation.

4. Cleaning, testing and disinfecting as required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1, General Requirements

B. Division 2, Sitework

C. Division 5, Metals

D. Division 9, Finishes

E. Division 11, Equipment

F. Division 16, Electrical

1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

A. The Contractor shall furnish to the Owner (through the Engineer) a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.

B. Shop Drawings for piping shall be prepared and submitted in accordance with Section 01300, Submittals. In addition to the requirements of Section 01300, Submittals, the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.

C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.

B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified herein.

C. Joints in piping shall be of the type as specified in the appropriate Piping System Schedule in Section 15390, Schedules.

D. All buried exterior piping shall have restrained joints for thrust protection unless otherwise specified or shown on the drawings. All exposed exterior piping shall have flanged joints, unless otherwise specified or shown on the drawings.

E. The Drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

2.02 WALL PIPES

A. Where wall sleeves or wall pipes occur in walls that are continuously wet on one or both sides, they shall have water stop flanges at the center of the casting or as shown on the Drawings. Ends of wall pipes shall be flange, mechanical joint, plain end, or bell as shown on the Drawings, or as required for connection to the piping. Wall pipes shall be of the same material as the piping that they are connected to. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange. Unless otherwise shown on the Drawings, waterstop flanges shall conform to the minimum dimensions shown below:

Pipe Size	Waterstop Flange Diameter	Waterstop Flange Thickness
4" - 12"	OD + 3.10"	0.50"

2.03 SLEEVES

A. Unless shown otherwise, all piping passing through walls and floors shall be installed in sleeves or wall castings accurately located before concrete is poured, or placed in position during construction of masonry walls. Sleeves passing through floors shall extend from the bottom of the floor to a point 3 inches above the finished floor, unless shown otherwise. Water stop flanges are required on all sleeves located in floors or walls which are continually wet or under hydrostatic pressure on one or both sides of the floor or wall.

B. Sleeves shall be cast iron, black steel pipe, or fabricated steel in accordance with details shown on the Drawings. If not shown on the Drawings, the Contractor shall submit to the Engineer the details of sleeves he proposes to install; and no fabrication or installation thereof shall take place until the Engineer's approval is obtained. Steel sleeves shall be fabricated of structural steel plate in accordance with the standards and procedures of AISC and AWS. Steel sleeve surfaces shall receive a commercial sandblast cleaning and then be shop painted in accordance with Section 09900 – Painting.

C. When shown on the Drawings or otherwise required, the annular space between the installed piping and sleeve shall be completely sealed against a maximum hydrostatic pressure of 20 psig. Seals shall be mechanically interlocked, solid rubber links, trade name "Link-Seal", as manufactured by Garlock Pipeline Technologies (GPT) or equal. Rubber link, seal-type, size, and installation thereof, shall be in strict accordance with the manufacturer's recommendations. For non-fire rated walls and floors, pressure plate shall

be glass reinforced nylon plastic with EPDM rubber seal and 304 stainless steel bolts and nuts. For fire rated walls and floors, two independent seals shall be provided consisting of low carbon steel, zinc galvanized pressure plates, silicon rubber seals and low carbon steel, zinc galvanized bolts and nuts.

D. Cast iron mechanical joint adapter sleeves shall be Clow # 1429, as manufactured by the Clow Corp., or equal. Mechanical joint adapter sleeves shall be provided with suitable gasket, follower ring, and bolts to effect a proper seal. In general, sleeves installed in walls, floors, or roofs against one side of which will develop a hydrostatic pressure, or through which leakage of liquid will occur, shall be so sealed. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange.

2.04 SOLID SLEEVE COUPLINGS (FOR BURIED SERVICE THROUGH 54-INCH)

A. Solid sleeve couplings shall be used to connect buried service piping where shown on the Drawings. Solid sleeves shall be ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Unless otherwise shown or specified, solid sleeve couplings shall be Style A11760 as manufactured by American Cast Iron Pipe Co., or equal. Solid sleeve couplings shall be restrained with wedge-type restraining glands to meet the pressures specified in 15390.

B. Alternatively, EBAA Iron 3800 Mega-Coupling is acceptable.

2.05 FLANGED COUPLING ADAPTERS

A. Flanged coupling adapters shall be furnished as required and as shown on the Drawings.

B. Flanged coupling adapters shall be of ductile iron or carbon steel construction and shall be rated for the same pressure as the connected piping.

C. All flanged coupling adapters shall be harnessed by tying the adapter to the nearest pipe joint flange using threaded rods and rod tabs unless otherwise approved by the Engineer.

D. Flanged coupling adapters shall be manufactured by Smith-Blair Model 911 or 920, Romac Industries RFCA , or equal.

E. Flanged coupling adapters shall be provided with manufacturer's fusion bonded epoxy painting system.

2.06 DISMANTLING JOINTS

A. Dismantling joints shall be furnished at locations shown on the Drawings.

B. Dismantling joints for sizes less than 12-inch shall be of ductile iron or carbon steel construction and shall be rated for the same pressure as the connected piping. Dismantling joints for sizes greater than 12-inches shall be of carbon steel construction and shall be rated for the same pressure as the connected piping.

C. Flanges for dismantling joints shall match the bolt pattern and pressure rating of the flanges for the connected piping.

D. All dismantling joints shall be restrained utilizing restraining rods provided by the manufacturer. Restraining rods shall be constructed from ASTM A193 Grade B7 steel. Restraining rods and restraint system shall be installed in strict accordance with manufacturer's recommendations.

E. Dismantling joints shall be provided with manufacturer's fusion bonded epoxy painting system.

F. Dismantling joints shall be manufactured by Smith Blair Model 975, Romac Industries Model DJ400, or equal.

2.07 UNIONS

A. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.

B. For PVC and CPVC piping, unions shall be socket weld type with Viton O-ring.

2.08 TAPPING SLEEVES AND TAPPING SADDLES

A. Tapping sleeves shall be similar to Mueller Outlet Seal, American Uniseal or Kennedy Square Seal. All sleeves shall have a minimum working pressure of 150 psi. All sleeves larger than twelve (12) inches shall be ductile iron. All taps shall be machine drilled; no burned taps will be allowed.

B. Tapping saddles may be used on mains sixteen (16) inches and larger where the required tap size does not exceed one-half the size of the main (i.e. 8-inch tapping saddle for use on a 16-inch main). Tapping saddles shall be manufactured of ductile iron providing a factor of safety of at least 2.5 at a working pressure of 250 psi. Saddles shall be equipped with a standard AWWA C-110-77 flange connection on the branch. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddles. Straps shall be of alloy steel. The tapping saddle shall be the American tapping saddle, U.S. Pipe tapping saddle, or equal. All taps shall be machine cut, no burned taps will be allowed.

2.09 HEAT TRACED PIPING

A. Exposed pipes to be insulated shall also be protected from freezing by heat tracing. Freeze protection heat tracing shall consist of twin 16 AWG copper brass wires with a semiconductor polymer core where electrical resistance varies with temperature. The heat tracing shall have a fluoropolymer outer jacket for corrosion resistance. The heat tracing shall be rated for three (3) watts per foot output, self-regulating with a maximum temperature of 150°F, equal to a Chromalox No. SRL3-1CT383400. Maximum length for tape shall be 300 feet for each circuit. Temperature controller shall be provided to sense pipe temperature to determine on or off condition of the heat tracing. Temperature control shall be equal to a Chromalox No. RTBC-2-384729. The heat tracing system shall operate on 120 VAC. See Drawings for installation detail. Heat tracing of piping shall be provided as specified in Section 15390 – Schedules and as indicated on the Drawings.

2.10 FLEXIBLE RESTRAINED EXPANSION JOINTS

A. Restrained expansion joints shall be manufactured of 60-42-10 ductile iron conforming to material and other applicable requirements of ANSI/AWWA C153/A21.53.

B. Each pressure containing component shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the materials requirements of, and tested in accordance with, ANSI/AWWA C213 and shall meet or exceed the requirements of ANSI/AWWA C550.

C. Seals shall conform to the applicable requirements of ANSI/AWWA C111/A21.11.

D. All bolts used in the assemblies shall be stainless steel and shall be coated with a premium quality epoxy.

E. Flanged ends shall comply with ANSI/AWWA C110/A21.10, with the addition of O-ring groove and O-ring.

F. Mechanical joint ends shall comply with ANSI/AWWA C153/A21.53.

G. Restrained expansion joints shall have a minimum pressure rating of 350 psi with a minimum safety factor of 3:1 assembly shall be tested at 350 psi before shipment.

H. Restrained expansion joints shall provide for self restraint without tie rods and shall provide for expansion and contraction capabilities cast as an integral part of the end connection.

I. Flexible restrained expansion joints shall allow for 8-inches (+6"-2") minimum expansion.

J. Flexible restrained expansion joints shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint having a minimum of 15° deflection per ball.

K. Restrained expansion joints shall be the Single Ball or Double Ball FLEX-TEND Expansion Joint as manufactured by EBAA Iron Inc., or equal.

2.11 COMBINATION AIR VALVES

A. General

1. Combination air valve assemblies shall be installed at all the locations specified herein and as indicated on the Drawings

2. All air valves shall be installed complete with all appurtenant piping as required for a complete and operable installation.

3. All installations shall include a ball valve of the same diameter as the nominal valve size located on the inlet side for isolation. The exhaust from the valve shall be piped to a suitable disposal point.

B. Single Body Combination Air Valves (sewage/buried pipelines)

1. General
   a. Air release and vacuum relief contained in single body housing and specifically designed for use with sewage force mains and shall be designed not to clog when used on force mains.
   b. Location: high points in pipelines and as shown.

2. Manufacturer and Model:
   a. ARI D-025
   b. Vent-O-Mat RGX Short Pattern
   c. or equal

3. Materials of Construction / Size / Accessories
   a. Body, Bottom Flange, and Cover Plate: Reinforced Nylon, 304 Stainless Steel,or Polypropylene.
   b. Floats: Foamed Polypropylene, HDPE
   c. Seals: BUNA-N
   d. Other Internal Parts: Reinforced Nylon, Polypropylene, HDPE, 304 Stainless Steel.
   e. Pipe Size: 2-inch NPT, threaded connection
   f. Nominal Valve Size: 2-inch
   g. Total valve length shall be less than 21 inches
   h. Provide Inlet isolating valve, bronze blow-off, flushing valves, and 5 ft (min) of rubber hose w/ quick disconnects to allow connection to a clean water source.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping connections to equipment shall be provided with unions or coupling flanges located so that piping may be readily dismantled from the equipment. At certain applications, Dresser, Victaulic, or equal, couplings may also be used. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to

give the appearance of good workmanship. Unless otherwise shown or approved, provided a minimum headroom clearance under all piping of 7 feet 6 inches.

B. Unless otherwise shown or specified, all waste and vent piping shall pitch uniformly at a 1/4-inch per foot grade and accessible cleanouts shall be furnished and installed as shown and as required by local building codes. Installed length of waste and vent piping shall be determined from field measurements in lieu of the Drawings.

C. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.

D. All excavation required by this contract shall be unclassified. No additional payment will be made for rock excavation required for the installation of pipe or structures shown on the drawings.

E. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

F. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.

G. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet. The Contractor shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the Engineer as to the condition and bearing value before any pipe is laid or bedding is placed.

H. No pressure testing shall be performed until the pipe has been properly backfilled in place. All pipe passing through walls and/or floors shall be provided with wall pipes or sleeves in accordance with the specifications and the details shown on the Drawings. All wall pipes shall be of ductile iron and shall have a water stop located in the center of the wall. Each wall pipe shall be of the same class, thickness, and interior coating as the piping to which it is joined. All buried wall pipes shall have a coal tar outside coating on exposed surfaces.

I. Joint deflection shall not exceed 75 percent of the manufacturers recommended deflection. Excavation and backfilling shall conform to the requirements of Section 02200 - Earthwork, and as specified herein. All exposed, submerged, and buried piping shall be adequately supported and braced by means of hangers, concrete piers, pipe supports, or otherwise as may be required by the location.

J. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of

pipe into trenches. Under no circumstances shall any of the materials be dropped or dumped into the trench.

K. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.

L. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.

M. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.

N. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.

O. At the close of each work day the end of the pipeline shall be tightly sealed with a cap or plug so that no water, dirt, or other foreign substance may enter the pipeline, and this plug shall be kept in place until pipe laying is resumed.

P. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.

Q. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used <u>exceptions</u>: closure pieces at manholes and areas where joint deflection is required.

R. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each manhole and any adjustments will be coordinated and approved by the Engineer.

S. Detector tape shall be installed 12 inches below final grade and directly above all buried potable water piping. The tape shall be blue and silver and shall be clearly and permanently labeled "<u>Water</u>". Detector tape shall be Lineguard III as manufactured by Lineguard, Inc., or equal.

3.02 DUCTILE IRON PIPE

A. Ductile iron pipe (DIP) shall be installed in accordance with the requirements of the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association, and AWWA C600.

B. Where it is necessary to cut ductile iron pipe in the field, such cuts shall be made carefully in a neat workmanlike manner using approved methods to produce a clean square cut. The outside of the cut end shall be conditioned for use by filing or grinding a small taper, at an angle of approximately 30 degrees.

C. Unless otherwise approved by the engineer, field welding of ductile iron will not be permitted.

3.03 PVC AND HDPE PIPE

A. Polyvinyl chloride (PVC), and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.

B. Plastic piping shall not be installed when the temperature is less then 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

3.04 JOINTS IN PIPING

A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.

B. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed, and the condition corrected.

C. Flanged joints shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places. Bolts or studs shall be uniformly tightened around the joints. Where stud bolts are used, the bolts shall be uniformly centered in the connections and equal pressure applied to each nut on the stud. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.

D. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution of mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.

E. Threaded and/or screwed joints shall have long tapered full depth threads to be made with the appropriate paste or jointing compound, depending on the type of fluid to be processed through the pipe. All pipe up to, and including 1-1/2-inches, shall be reamed to remove burr and stood on end and well pounded to remove scale and dirt. Wrenches on valves and fittings shall be applied directly over the joint being tightened. Not more than three pipe threads shall be exposed at each connection. Pipe, in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot. Joints in all piping used for chlorine gas lines shall be made up with a glycerine and litharge cement. Joints in plastic piping (PVC/CPVC) shall be laid and joints made with compounds recommended by the manufacturer. Installation shall conform to the requirements of ASTM D2774 and ASTM D2855. Unions required adjacent to valves and equipment.

F. Soldered joints shall have the burrs removed and both the outside of pipe and the inside of fittings shall be thoroughly cleaned by proper tools recommended for that purpose. Flux shall be applied to both pipe and inside of fittings and the pipe placed into fittings and rotated to insure equal distribution of flux. Joints shall be heated and solder applied until it shows uniformly around the end of joints between fitting and pipe. All joints shall be allowed to self-cool to prevent the chilling of solder. Combination flux and solder paste manufactured by a reputable manufacturer is acceptable. Unions required adjacent to valves and equipment.

G. Welded joints shall be made by competent operators in a first class workmanlike manner, in complete accordance with ANSI B31.1 and AWWA C206. Welding electrodes shall conform to ASTM A233, and welding rod shall conform to ASTM A251. Only skilled welders capable of meeting the qualification tests for the type of welding which they are performing shall be employed. Tests, if so required, shall be made at the expense of the Contractor, if so ordered by the Engineer. Unions shall be required adjacent to valves and equipment.

I. Solvent or adhesive welded joints in plastic piping shall be accomplished in strict accordance with the pipe manufacturer's recommendations, including necessary field cuttings, sanding of pipe ends, joint support during setting period, etc. Care shall be taken that no droppings or deposits of adhesive or material remain inside the assembled piping. Solvent or adhesive material shall be compatible with the pipe itself, being a product approved by the pipe manufacturer. Unions are required adjacent to valves and equipment. Sleeve-type expansion joints shall be supplied in exposed piping to permit 1-inch minimum of expansion per 100 feet of pipe length.

J. Dielectric isolation such as flange isolation kits, dielectric unions, or similar, shall be installed wherever dissimilar metals are connected according to the following table.

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Zinc			●	●	●	●	●	●	●
Galvanized Steel			●	●	●	●	●	●	●
Aluminum	●	●		●	●	●	●	●	●
Cast Iron	●	●	●				●	●	●
Ductile Iron	●	●	●				●	●	●
Mild Steel/ Carbon Steel	●	●	●				●	●	●
Copper	●	●	●	●	●	●			●
Brass	●	●	●	●	●	●			●
Stainless Steel	●	●	●	●	●	●	●	●	

1. "●" signifies dielectric isolation is required between the two materials noted.
2. Consult Engineer for items not listed in table.
3. Provide flange isolation kits for all flanged connections of dissimilar metals and hardware including connections to equipment.
4. Contractor shall include all isolation descriptions with piping submittals.

K. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

L. Joints in polypropylene and polyvinylidelene fluoride pipe shall be butt fusion weld. All butt welding shall follow the requirements of ASTM D-2657 and the manufacturer's recommendations.

3.05 FLUSHING AND TESTING

A. All piping shall be properly flushed and tested unless specifically exempted elsewhere in the Specifications or otherwise approved by the Engineer. Air and gas pipelines shall be flushed and tested with compressed air. Gravity sewer piping shall be flushed and tested as specified in Section 02604 - Utility Structures. All other liquid conveying pipelines shall be flushed and tested with water. The Contractor shall furnish and install all means and apparatus necessary for getting the air or water into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be flushed and

tested in such lengths or sections as agreed upon among the Owner, Engineer, and Contractor. Test pressures shall be as specified in Section 15390 – Schedules, and shall be measured at the lowest point of the pipe segment being tested. The Contractor shall give the Owner and Engineer reasonable notice of the time when he intends to test portions of the pipelines. The Engineer reserves the right, within reason, to request flushing and testing of any section or portion of a pipeline.

B. The Contractor shall provide water for all flushing and testing of liquid conveying pipelines. Raw water or non-potable water may be used for flushing and testing liquid pipelines not connected to the potable water system. Only potable water shall be used for flushing and testing the potable water system.

C. Air and gas piping shall be completely and thoroughly cleaned of all foreign matter, scale, and dirt prior to start-up of the air or gas system.

D. At the conclusion of the installation work, the Contractor shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period. If after this cleaning any obstructions remain, they shall be corrected by the Contractor, at his own expense, to the satisfaction of the Engineer. Liquid conveying pipelines shall be flushed at the rate of at least 2.5 feet per second for a duration suitable to the Engineer or shall be flushed by other methods approved by the Engineer.

E. Compressed/service air and gas piping shall be flushed by removing end caps from the distribution lines and operating one (1) compressor, in accordance with the manufacturer's instructions.

F. After flushing, all air piping shall be pressure and leak tested prior to coating and wrapping of welded joints. Immediately upon successful completion of the pressure and leak test, welded joints shall be thoroughly cleaned of all foreign matter, scale, rust, and discoloration and coated in accordance with the Specifications.

G. All process air piping shall be leak tested by applying a soap solution to each joint. Leak tests shall be conducted with one (1) blower in service at normal operating pressure.

H. During testing the piping shall show no leakage. Any leaks or defective piping disclosed by the leakage test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

I. All buried process air piping shall be pressurized to 25 psig and tested for leaks by applying a soap solution to each joint. The air supply shall be stopped and the pipe pressure monitored. System pressure shall not fall by more than 0.5% of the 25 psig test pressure over a one-hour test period. Should the system fail to hold the required pressure for one hour, the cause shall be determined and corrected and the test repeated until a successful test of the entire system is obtained.

J. Field leakage tests shall be performed for all submerged process air piping. The procedure shall consist of operating the system under clear nonpotable water for visual identification of all leaks. All field leakage tests shall be witnessed by the Engineer. All submerged piping shall be installed free of any leaks.

K. After flushing, all liquid conveying pipelines shall be hydrostatically tested at the test pressure specified in the appropriate Piping System Schedule in Section 15390 – Schedules. The procedure used for the hydrostatic test shall be in accordance with the requirements of AWWA C600. Each pipeline shall be filled with water for a period of no less than 24 hours and then subjected to the specified test pressure for 2 hours. During this test, exposed piping shall show no leakage. Allowable leakage in buried piping shall be in accordance with AWWA C600.

L. Any leaks or defective pipe disclosed by the hydrostatic test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

M. After flushing, all gas piping shall be leak tested in accordance with all local codes and regulations and in conformance with the recommendations or requirements of any National Institute or Association for the specific service application.

3.06 DISINFECTION

A. All pipe and fitting connected to and forming a part of a potable water supply shall be disinfected in accordance with the procedures described in AWWA C 651. Disinfection shall also be in accordance with the requirements of the Virginia Department of Health and the Owner.

B. Disinfection shall be accomplished after the pipe has been flushed, if applicable, and passed the hydrostatic test. Such piping shall be filled with 50 parts per million (PPM) of chlorine and held in contact for not less than 24 hours. Final tests after 24 hours contact time shall show a minimum residual chlorine content of 10 ppm in all parts of the system. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or VDH and/or the Owner until the minimum residual chlorine content of 10 ppm has been reached. The Contractor shall obtain certificates of satisfactory bacteriological tests and furnish them to the Owner before the request is made for acceptance of the work. The Contractor shall furnish and install, at his own expense, all means and apparatus necessary for performing the disinfection. The chlorine solution shall be thoroughly flushed out prior to placing the new sections of pipe in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant, or fish life. Chlorine residual tests will be made after flushing to assure that residual is not in excess of 1 ppm at any point in system.

3.07 PAINTING AND COLOR CODING SYSTEM

A. All piping specified in this Section shall be painted in accordance with Section 09900 – Painting, except as follows:

1. Copper pipe

2. Stainless steel pipe. Flanges and supports or hangers shall be painted.

- END OF SECTION -

SECTION 15006

DUCTILE IRON PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. All ductile iron pipe and specials shall be marked with the manufacturer's name or trademark, size, weight, thickness class, the date of manufacture, and the word "Ductile".

B. Ductile iron pipe (DIP) of the sizes shown or specified shall conform to ANSI A21.51 (AWWA C151), Grade 60-42-10 for ductile iron pipe centrifugally cast in metal molds or sand-lined molds. All ductile iron pipe shall conform to ANSI A21.50 (AWWA C150) for thickness design and shall be supplied in 18 or 20 foot nominal lengths or as required to meet the requirements of the Drawings. Fittings and specials shall be cast iron or ductile iron, conforming to the requirements of ANSI A21.10 (AWWA C110) or ANSI A21.53 (AWWA C153).

C. Minimum Class 53 pipe shall be used for flanged spools.

D. Reference Section 15000, Basic Mechanical Requirements

E. Reference Section 15390, Schedules, for pressure rating requirements for specific applications.

PART 2 -- PRODUCT

2.01 DUCTILE IRON PIPE AND FITTINGS

A. All pipe and fittings shall be Epoxy lined. Lining shall be minimum 40 mils nominal dry thickness of Protecto 401 epoxy. All buried DIP and fittings shall have a bituminous coating on the exterior surfaces in accordance with ANSI A21.51 (AWWA C151) and shall be provided with polyethylene encasement. All exposed DIP and fittings shall have a shop applied prime coat in accordance with Section 09900 - Painting.

B. Requirements for various types of joints are described in the following paragraphs. Unless otherwise noted herein or on the drawings, all exposed ductile iron piping shall have flanged joints.

C. Flanged joints and fittings shall have a minimum pressure rating of 250 psi with 125 lb. American Standard flanges. All flanges and fittings shall conform to the requirements of ANSI B16.1. Flanges shall be ductile iron and shall be of the threaded or screw on type. The face of the flanges shall be machined after installation of the flange to the pipe. No raised surface shall be allowed on flanges. Flanged pipe shall conform to the requirements of ANSI Specification A21.15, (AWWA C115). Pipe lengths shall be fabricated to meet the requirements of the Drawings.

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D. Gaskets shall be the "Ring Gasket" type, 1/8-inch minimum thickness, cloth inserted rubber, red rubber or neoprene and shall be suitable for the service intended. Gaskets for glass lined pipe shall be TORUSEAL flange gasket, or equal. Bolts shall be of the size and length called for and in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. The bolts for flanged joints shall be a minimum ASTM A307; Grade B carbon steel and be in accordance with ANSI A21.10, (AWWA C110). The bolts shall have hexagonal heads and nuts, no washers shall be used.

E. Bell and spigot pipe shall be provided with push on, O-ring rubber gasket, compression type joints and shall conform to the requirements of ANSI A21.11 (AWWA C111). Fittings and specials shall be supplied with mechanical joints as specified for mechanical joint pipe. If required by installation conditions, pipe shall have cast-on lugs for adequately tying it together.

F. Mechanical joints and fittings shall conform to the requirements of ANSI A21.11, (AWWA C111). Joints shall be made employing a tapered rubber gasket forced into a tapered groove with a ductile iron follower ring. If required by installation conditions, pipe and fittings shall have cast-on lugs for adequately tying the pipe and fittings together. These shall be in conformance with standard practice and as outlined under the appropriate AWWA Specifications.

G. Bolts for mechanical joints shall be high strength corrosion resistant low-alloy steel tee-head bolts with hexagonal nuts.

H. Mechanical coupling joint pipe and fittings shall be split type, shouldered end. Coupling materials shall be malleable iron. Couplings shall have a minimum pressure rating and service equal to that of the connected piping. Gaskets shall be of rubber. Bolts and nuts shall be heat treated carbon steel track bolts and shall be plated. After installation, buried couplings shall receive two heavy coats of coal tar epoxy (min. 24 mil thickness) which is compatible with the finish of the couplings. Couplings shall be as manufactured by Victaulic Company of America Style 31, or equal.

I. Restrained joint pipe shall consist of factory manufactured bolted retainer rings, ductile iron locking segments held in place by rubber retainers, or ductile iron retaining rings that lock over the bell of the joint and are secured to prevent rotation, and factory welded retainer beads or rings on the spigot of the pipe. All components of the bolted or snap ring assemblies shall be constructed of corrosion-resistant, high strength, low-alloy steel. Restrained joint pipe shall be Flex-Ring or Lock-Ring type joints as manufactured by American Cast Iron Pipe Company, HP LOK or TR Flex as manufactured by US Pipe, Bolt-Lok or Snap-Lok as manufactured by Griffin Pipe Products, TR Flex or Super Lock as manufactured by Clow Water Systems Co., or approved equal.

J. Restrained fittings for piping systems 16-inches in diameter and greater shall have factory restraint systems identical to the factory restrained joint pipe specified in Item K above. All fittings shall be minimum pressure Class 250 unless otherwise specified.

K. Restrained fittings for pipe systems 14-inches in diameter and smaller shall be Mechanical Joint fittings with restraint assemblies such as Stargrip by Star Pipe Systems, Mega Lug by EBAA Iron, ONE LOK by Sigma, Grip Ring by Romac, or approved equal. Where threaded-

rods are allowed, the rods and tabs shall be designed for the specified restraint system design pressure, shall have lengths less than 10 feet between fittings, and shall be painted with two heavy coats of coal tar epoxy after installation.

L. The manufactured systems for thrust restraint indicated above shall be used where restrained joint ductile iron pipe and fittings are specified or indicated on the drawings. Gripping gaskets are not an acceptable form of restraint. Thrust restraint and harnessing systems such as threaded-rods, friction clamps, retainer glands shall be used only where specifically specified herein, indicated on the drawings or if allowed by the Engineer in isolated applications where conditions warrant and necessitate their use. Concrete thrust blocks may be used in accordance with the schedule indicated on the drawings, if applicable.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 15008

PVC/CPVC PIPE AND THERMOPLASTIC HOSE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC pipe and fittings shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein, in Section 15390 - Schedules, or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. PVC pipe shall be Type 1 Grade 1 conforming to ASTM D 1784 and D 1785. Fittings shall conform to the following standard specifications:

Socket Type (Schedule 40); ASTM D 2466
Socket Type (Schedule 80); ASTM D 2467

D. Provide flanged fittings of the same material as the specified pipe and material conforming to ANSI B16.5 at all valves and equipment with Teflon filled or natural rubber gaskets. Bolts shall be type 316 stainless steel for flanged joints. Flanges are not required at true (double) union valves.

E. Solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.

F. C900-Class 200 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chloride (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 14 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total

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footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 914 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 985 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 200, DR 14 shall be ductile iron, bolted mechanical joint.

G. C900-Class 150 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chlorine (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 18 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2677. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 435 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 755 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 150, DR 18 shall be ductile iron, bolted mechanical joint.

H. PVC pressure rated pipe (PR 160) shall be in sizes between 1 1/2 inches and 12 inches and shall conform to all the requirements of ASTM D1784 and ASTM D2241 and shall be a minimum of SDR 26 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (1± inch). Random lengths of not more than 15% of the total

footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed materials shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 135 psi for all sizes when tested in accordance with ASTM D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 500 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.
5. The pipe shall be designed to pass for 1000 hours a sustained test pressure of 340 psi when tested in accordance with ASTM D1598, as referenced in ASTM D2241.

I. Fittings for PR 160, SDR 26 shall be PVC and designed for the pipe being supplied.

J. Perforated and closed drainage pipe and fittings shall be rigid PVC pipe, Schedule 40 unless otherwise shown or specified with solvent welded type joints, or approved equal. Pipe shall be slotted or have two rows of 1/4-inch diameter holes spaced 4-inches apart along the circumference of the pipe. Longitudinal spacing of holes shall be 5-inches maximum.

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SECTION 15020

PIPE SUPPORTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and design calculations required to provide pipe supports in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 3, Concrete – Appropriate and Related Sections

B. Section 05010 – Metal Materials

C. Section 05035 – Galvanizing

D. Section 05050 – Metal Fastening

E. Section 05061 – Stainless Steel

F. Section 05120 – Structural Steel

G. Section 15000 – Basic Mechanical Requirements

1.03 SUBMITTALS

1. Applicable and associated cut sheets and drawings for materials and support components shall be submitted with the Shop Drawings in accordance with or in addition to the submittal requirements specified in Section 01300 – Submittals: Section 15000 – Basic Mechanical Requirements and other referenced Sections above.

2. Catalog cut information on all system components such as pipe supports, hangers, guides, anchors, and channel-type supports.

3. Drawings of the piping support systems, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide and anchor type by catalog number and Shop Drawing detail number.

4. With each piping support system Shop Drawing, the Contractor shall attach calculations prepared and sealed by a Professional Engineer licensed in the Commonwealth of Virginia showing that the piping support system complies with the specified requirements, including all building code and seismic code requirements pertaining to support of piping and other non-structural components.

5. Table showing the manufacturer's recommended hanger support spacing for PVC, CPVC and FRP pipe for the services listed in Section 15390 – Schedules.

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1.04 QUALITY ASSURANCE

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Professional Engineer licensed in the Commonwealth of Virginia.

PART 2 – PRODUCTS

2.01 GENERAL

A. The Contractor shall be responsible for the design of all piping support systems not specifically designed by the Engineer and detailed on the Drawings. The supports typically detailed on the Drawings, not included on Standard Detail Drawings, are designed to resist resulting external thrust forces in addition to gravity, seismic and other applicable loads required by the governing building code.

B. No attempt has been made to show all of the required pipe supports either on the main Drawings or on the standard detail drawings. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility of providing them throughout the project at no additional cost to the Owner.

C. Where special pipe support fabrications are required, products and execution shall be as specified in related Sections of the Specifications.

D. Existing piping support systems to support new piping shall only be used if the Contractor can show and demonstrate by submitting supporting calculations that they are adequate for the additional load imposed by the new piping, or if they are strengthened to support the additional load.

E. Design Criteria for Piping Support Systems:

1. Design pipe supports for dead loads imposed by the weight of the pipes filled with water, except for air and gas pipelines, plus the weight of insulation. If applicable by location, ice loads per code shall be applied as indicated in the governing building code.

2. Design for the thermal expansion and contraction of the piping and its associated pipe support and pipe expansion systems and couplers.

3. Design the pipe supports for all seismic loading requirements and conditions as specified in the governing building code and referenced seismic design codes.

4. A minimum safety factor of 2 or as approved by the Engineer, based upon the yield strength of the support material, shall be used for pipe supports, braces, hangers, and guides as well as for beam and column members used in channel-type support systems.

5. The horizontal pipe hanger and/or floor support spacing shall be as recommended

by the pipe and/or hanger manufacturer, but shall not exceed 10 feet on center unless indicated otherwise herein or on the Drawings.

6. Seismic and sway bracing shall be provided at maximum 10-foot centers.

7. The design, sizing and spacing of anchor bolts, including concrete anchors, shall be based on withstanding shear and pullout loads imposed by loading at each particular support. The minimum anchor bolt size shall be ½ inches in diameter.

2.02 HANGERS AND SUPPORTS

A. All piping shall be adequately supported and braced by means of steel hangers and/or supports, concrete piers, supplemental lateral bracing components, pre-fabricated brackets, or otherwise as may be required by the location and forces applied per governing code, including gravity and lateral forces from earthquake and/or wind (if exterior). Generally, concrete supports shall be used where pipe centerline is less than 3 feet above floor, and hangers above 6 feet unless specified or shown otherwise. Supports shall be not more than 10 feet on center for steel and cast iron, 5 feet on center for plastic unless otherwise shown on the Drawings or required by the specific manufacturer. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing hangers and supports to the structure. Refer to Standard Detail Drawings.

1. Metal pipe support materials, where stainless steel pipe is supported, shall be Type 304 stainless steel meeting the requirements of Section 05061 - Stainless Steel.

2. Metal pipe support materials, where carbon steel, ductile or other ferrous pipe is supported, shall be Type 304 stainless steel meeting the requirements of Section 05061 – Stainless Steel.

3. Metal pipe supports indicated as standard type pipe hangers are designed and detailed for gravity loading only. Resulting lateral loads from wind, earthquake, or other lateral loads per code, or special loading conditions during construction, shall be applied to the pipe in accordance with the governing building code. Supplemental lateral stiffening members (when necessary) shall be provided along pipe or at gravity supports using appropriate supplemental members and connections when required by calculations. The Contractor shall include design calculations and details with all pipe hangar and support submissions for review by the Engineer. The main structure and structural components that will support the pipe hangers and other appurtenant components of the facility have been designed to resist all resulting secondary lateral loading from pipe hangers and other non-structural members for gravity and resulting lateral loads.

B. Hangers and supports shall conform to the following requirements:

1. All fabricated metal hangers and supports shall be capable of adjustment after installation. Different types of hangers and supports along a pipe length, including bends, shall be kept to a minimum.

2. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.

3. Vertical piping shall be properly supported at each floor and between floors by stays or braces to prevent rattling and vibration.

4. Supports and hangers for plastic and FRP piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.

5. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless steel hangers.

6. Ferrous pipes to be painted shall be painted in accordance with Section 09900 - Painting. Ferrous pipes that require painting or galvanizing shall be supported by galvanized hangers and supports. Stainless steel piping shall be supported by stainless steel saddles and straps (if required).

7. Copper piping shall be supported by plastic coated or copper plated steel hangers and supports.

8. Plastic piping shall be supported by plastic coated steel hangers and supports.

9. Hangers and supports shall provide for thermal expansion throughout the full operating temperature range.

10. Expansion and adhesive type anchors used for pipe hangers and supports shall be Type 304 stainless steel.

C. Metallic hangers and supports may be standard make by Anvil International, Inc., "Witch" by Carpenter & Paterson, Ltd., B-Line Systems, Inc., or equal; and data on the types and sizes to be used shall be furnished to the Engineer for approval. Metallic support system brackets, rods, support clips, clevis hangers, hardware, etc. shall be cast iron or welded steel construction. All gravity type hangers and supports shall be restrained laterally to resist seismic loading and other loading as required by the governing code.

D. Non-metallic support system shall be a heavy duty channel framing system. Channel frames shall be manufactured by the pultrusion process using corrosion grade polyester or vinylester resins. All fiberglass construction shall include suitable ultraviolet inhibitors for UV exposure and shall have a flame spread rating of 25 or less per ASTM E84. Piping accessories, pipe clamps, clevis hangers, support posts, support racks, fasteners, etc., shall be constructed of vinylester or polyurethane resin. Non-metallic support systems shall be standard make Aickinstrut by Aickinstrut, Inc., Unistrut Fiberglass by Unistrut, Inc., Enduro Fiberglass Systems, or equal. The Contractor shall submit data on the types and sizes of approval. Unless otherwise shown or specified the Contractor shall provide support spacings in the conformance with the pipe and support system manufacturer's requirements.

PART 3 -- EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Support piping connections to equipment by pipe support and not by the equipment.

B. Support large or heavy valves, fittings, flow meters and appurtenances independently of the connected piping.

C. Support no pipe from the pipe above it.

D. Support piping at changes in direction or in elevation, adjacent to flexible joints, expansion joints, and couplings, and where shown.

E. The Contractor shall not install piping supports and hangers in equipment access areas or bridge crane runs.

F. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

G. Install pipe anchors (fixed supports and/or guides) where shown and/or as may otherwise be required to withstand expansion thrust loads and to direct and control thermal expansion. The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that complete details describing location, pipe supports and hydraulic thrust protection are submitted.

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SECTION 15095

VALVES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.

B. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated. Except where noted otherwise, valves designated for water service shall conform to pertinent sections of the latest revision of AWWA C500 Specifications. Cast iron valve bodies and parts shall meet the requirements of the latest revision of ASTM Designation A-126, "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B."

C. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.

D. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. The Contractor shall be responsible for coordinating connecting piping. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.

1.02 SUBMITTALS

A. The Contractor shall furnish to the Owner, through the Engineer, a Performance Affidavit where required in individual valve specifications, utilizing the format specified in Section 11000, Equipment General Provisions. Performance tests shall be conducted in accordance with the latest revision of AWWA C500 and affidavits shall conform to the requirements of the Specifications

B. Shop Drawings conforming to the requirements of Section 01300, Submittals, are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn using a ladder-type format in

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accordance with JIC standards. Shop Drawings for pneumatically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.

C. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall provide the services of a qualified representative of the manufacturer(s) of the valves installed to check out and certify the installation(s), to supervise the initial operation, and to instruct the Owner's operating personnel in proper operation and maintenance procedures.

B. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies notes.

PART 2 -- PRODUCTS

2.01 FLOW INDICATORS

A. Flow indicators shall be the Akron ball-type as manufactured by Brooks Instrument Co., Fischer and Porter, or equal, and shall have bronze bodies, glass dome, and plastic ball.

2.02 CORPORATION STOPS

A. Corporation stops shall be of bronze with tapered male iron pipe threads on inlets and outlets. Terminal outlets shall have screwed bronze hex head dust plugs or caps. Unions shall be used on all corporation stop outlets with connecting piping. Corporation stops shall have a minimum working pressure rating of 250 psi and shall be as manufactured by Mueller Co., Hays Mfg. Div. of Zurn Industries, or equal.

2.03 VALVE BOXES

A. The Contractor shall furnish and install valve boxes as shown on the Drawings and specified herein.

B. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the valve box, sloped outwards.

C. All valve boxes shall be 2-piece cast iron, sliding type, 5-1/4" shaft, with heavy duty traffic weight collar and the lid marked with the appropriate carrier product (i.e.: WATER). Boxes shall be Valve Box Adaptor II as manufactured by Adaptor, Inc or approved equal.

2.04 QUICK DISCONNECT COUPLINGS

A. Quick disconnect type coupling for compressed/service air shall be provided where indicated on the Drawings. Coupling shall provide for instantaneous shutoff in socket end when lines are disconnected. Couplings shall be constructed of 316 stainless steel with a BUNA N O ring and integral safety lock. Couplings shall comply with Military Specification 4109 (interchangeable with standard plug of the same size).

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Except where noted otherwise herein, all valves shall be installing and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes and shall bear no stresses due to loads from the adjacent pipe. The Contractor shall be responsible for coordinating connecting piping.

B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated and cylinder operated valves shall be tested for control operation as directed by the Engineer.

C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.

D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Engineer. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.

E. Valve boxes shall be set plumb and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

3.02 SHOP AND FIELD TESTING

A. Shop and field testing of valves shall be as follows:

1. Certified factory testing shall be provided for all components of the valve and operator system. Valves and operators shall be shop tested in accordance with the requirements in the latest revision of AWWA C500, including performance tests, leakage test, hydrostatic tests, and proof-of-design tests. The manufacturer through the Contractor shall submit certified copies of the reports covering the test for acceptance by the Engineer.

2. Shop testing shall be provided for the operators consisting of a complete functional check of each unit. Any deficiencies found in shop testing shall be corrected prior to shipment. The system supplier through the Contractor shall submit written certification that shop tests for the electrical/pneumatic system and all controls were successfully conducted and that these components provide the functions specified and required for proper operation of the valve operator system.

3. The Contractor shall conduct field tests to check and adjust system components, and to test and adjust operation of the overall system. Preliminary field tests shall be conducted prior to start-up with final field tests conducted during start-up. The factory service representative shall assist the Contractor during all field testing and prepare a written report describing test methods, and changes made during the testing, and summarizing test results. The service representative shall certify proper operation of the valve operator system upon successful completion of the final acceptance field testing.

4. Preliminary and final field tests shall be conducted at a time approved by the Engineer. The Engineer shall witness all field testing.

5. All costs in connection with field testing of equipment such as energy, light, lubricants, water, instruments, labor, equipment, temporary facilities for test purposes, etc. shall be borne by the Contractor. The Contractor shall be fully responsible for the proper operation of equipment during tests 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.

6. Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components. Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly. The preliminary field test report must be approved by the Engineer prior to conducting final field acceptance tests. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation specified or otherwise directed by the Engineer.

7. Final field acceptance tests shall be conducted simultaneously with the start-up and field testing of the pumps, air compressors, process air blowers, etc. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing. Performance of pneumatic valves and compressed air system

under normal operating conditions and during simulated power failures shall be checked.

8. Field testing shall include optimization of opening and closing times of the valves. The Contractor shall provide the means for accurate measurement of pipeline pressures as directed by the Engineer. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

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SECTION 15105

CHECK VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

B. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

PART 2 -- PRODUCTS

2.01 SWING CHECK VALVES

A. Unless otherwise specified, check valves 3-inches and less shall be bronze, Y-pattern, swing check valves of the regrinding type. Valves shall have a minimum 200 psi non-shock cold water pressure rating and shall be as manufactured by Jenkins Bros. Corp., Crane Company, or equal.

B. Check valves larger than 3-inches shall be cushioned swing check valves rated for a minimum working pressure of 200 psi and shall be of the "Shockless Swing-Check" type as manufactured by G.A. Industries, or equal.

C. Valve closure shall be controlled by an external weighted lever arm, the action of which is cushioned by a hydraulic oil or pneumatic cylinder. Counterweights and cushion cylinders shall be designed so that adjustments can be made in the field to minimize surge and to prevent backflow and hammering noises during actual service conditions. The hydraulic oil or pneumatic cushion system shall be completely self-contained.

D. Valve bodies, cover discs, levers, and disc arms shall be constructed of heavy cast iron or cast steel fully conforming to the latest revision of ASTM A-126 Class B or Class WCB, respectively. Valve ends shall be Standard American 125 pound flat-faced flanged, in accordance with ANSI B16.1. Each valve disc shall be suspended from a noncorrosive shaft which shall pass through a stuffing box and be connected on the outside of the valve to the cushion and counterweight mechanism.

E. Valve seating shall be rubber-to-metal designed for drop-tight shutoff. The body seat ring shall be made of bronze or stainless steel and the disc seat ring of 80 Durometer rubber. Body and disc seats shall be renewable.

F. With the exception of the valve body and seat, all parts in contact with water shall be manufactured from noncorrosive materials. Internal corrosive surfaces shall be shop painted with two coats of 10 mils each of epoxy for corrosion resistance. Exterior surfaces shall be painted in accordance with the requirements of Section 09900, Painting.

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PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15107

YARD HYDRANTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 YARD HYDRANTS

A. Service water system hydrants shall be of the 2-inch non-freeze post-yard type with bronze casing, neoprene plunger. The barrel shall be self-draining; operating parts must be removable through the top of the hydrant.

B. The cold-rolled steel stem shall operate with a bronze operating nut. Stem threads shall be lubricated through the top of the operating nut tapped for grease fittings. Packing shall be double "O" rings to insure a positive shutoff with a minimum of packing friction when the hydrant is being operated. Each hydrant shall be equipped with suitable adapters to connect 2-inch and 3/4-inch hoses.

C. Each hydrant shall be supplied with 10-inch operating hand wheel and a steel post-mounted hose rack.

D. The hydrants shall be models Z-1390 as manufactured by Zurn, 5914 by Smith Company, or equal.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15108

GATE VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 GATE VALVES

A. Gate valves shall fully comply with the requirements of AWWA C515 for resilient wedge gate valves and shall be manufactured by Muller, American Flow Control, Kennedy, or equal.

B. Gate valves shall be designed for a minimum working pressure of 150 psi and tested at a pressure no less than 300 psi. Valves shall be capable of drip-tight, bidirectional shutoff.

C. Gate valve body shall be ductile iron with 2 coats, 10 mil each coat of fusion bonded epoxy coating on the interior and exterior in accordance with AWWA C550. The wedge shall be ductile iron encapsulated with EPDM.

D. Buried valves shall be suitable for buried service and shall operate in the vertical position. Valves shall be the non-rising stem type with standard 2-inch operating nut. Valves shall open left (counter-clockwise).

E. Exposed valves shall be the outside screw and yoke type (OS&Y) with manual handwheel operator. Valves shall open left (counter-clockwise).

F. Buried service valve ends shall be mechanical joint. Exposed valve ends shall be flange X flange

PART 3 – EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 15109

PLUG VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 PLUG VALVES

A. Plug valves shall be of the non-lubricated, eccentric seating plug type with synthetic rubber-faced plugs as manufactured by DeZurik Company, Val-Matic, or equal. All valves shall be provided with limit stops and rotate 90° from fully open to fully shut. The minimum working pressure for all valves shall be 150 psi, and the test pressure shall be at least 270 psi for valves up through 12-inch and at least 230 psi for valves 14-inch and larger. Valves shall be rectangular port plug valves. The port area of valves shall be at least 99 percent of full pipe area, unless otherwise specified herein or indicated in the appropriate Valve Schedule in Section 15390, Schedules. The body materials shall be of epoxy coated cast iron or semi-steel, unless specified otherwise. Seats shall have a welded overlay of 90 percent pure nickel and machined to a finish containing no stress cracks. Plug facings shall be of Hycar, or equal and completely suitable for use with domestic sewage.

B. The shaft seal shall be either the bronze cartridge type with at least two O-Rings, monolithic V-Type, U-Cup Type, or pull down packing type. If monolithic V-Type, U-Cup Type, or pull down packings are utilized, it shall be self-adjusting, self-compensating type. Packing shall be as manufactured by Chevron, or equal. Plug valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator.

C. All buried valves shall have mechanical joint ends (unless otherwise shown), conforming to ANSI A21.11 (AWWA C 111), and shall be operated with a standard AWWA 2-inch square nut through a totally enclosed worm gear actuator. Valve boxes shall be installed with all buried plug valves and shall be as specified herein.

D. Unless otherwise shown, all exposed valves 4-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150 pound standard with face-to-face dimensions of standard plug valves. Valves smaller than 4-inches in diameter shall have screwed ends, unless otherwise noted.

E. Valves 6-inches in diameter and smaller shall have lever operators, unless otherwise specified or noted on the Drawings. Manual operators for plug valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators.

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F. The manufacturer shall certify that the plug valves are capable of operating in continuous duty service under these pressures and flow conditions.

G. Each valve shall by hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

H. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness each coat) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15390

SCHEDULES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basin Mechanical Requirements.

1.02 PIPING SCHEDULES

A. Piping requirements for this Section are outlined on the Drawings and in the Piping Schedules. In the absence of a specified test pressure, pipe shall be tested at the greater of: 1) 150 percent of working pressure as determined by the Engineer or 2) 10 psig, unless the Schedule indicates no test is required.

B. If the pipe material is not shown on the Piping Schedule or otherwise specified, the following materials shall be used.

Service	Size Range, inches	Pipe	Type of Joint	Class/Design	Test Pressure
Sewage Piping	8" (Gravity)	PVC	Bell and Spigot (Buried)	SDR 26	N/A
	4" - 8" (Force Main)	Ductile Iron	Flanged (Exposed)	Class 53	80 psi
	4" - 8" (Force Main)	Ductile Iron	Restrained Push-on or MJ (Buried)	Class 53	80 psi
Potable Water Piping[1,2]	2"	Polyethelene	Per City Standard	Per City Standard	Per City Standard
Potable Water Piping (buried)	3/4" and 2"	Copper	Sodered	Per Section 15400	120 psi
Potable Water Piping (exposed)	3/4"	Copper	Sodered	Per Section 15400	120 psi
Drain Piping	1"-3"	PVC	Bell and Spigot (Buried)	Schedule 40	N/A

(1) Test at 150 percent of working pressure or 10 psi, whichever is greater.
(2) Polyethelene piple to be used upstream of water meter for Pennslyviana Avenue, copper pipeing to be used downstream of water meter.
(3) Polyethelene pipe to transition to copper inside of electrical building.
(4) Heat trace all exposed water piping.

1.03 VALVE SCHEDULES

A. Valves shall be as shown on Drawings.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15400

PLUMBING

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. The Contractor shall furnish all labor, equipment and material for the complete installation of the plumbing system as indicated on the Drawings and specified herein.

B. Plumbing systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

C. Provide the following Plumbing Equipment.

1. Potable water piping systems.
2. Pipe supports, hangers, escutcheon plates, and sleeves.
3. Plumbing pipe insulation.
4. Plumbing Fixtures
5. Water Heaters.
6. Reduced Pressure Zone Backflow Preventer (RPZ).
7. Shut-off valves

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Division 1, Submittals.

B. Data to be submitted shall include but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
2. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.

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3. Weight of all component parts and assembled weight.

4. Electrical characteristics, wiring, diagrams, etc.

5. Sample data sheet of equipment nameplate(s) including information contained thereon.

6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.

7. Details of special fasteners and accessories.

8. Type of adhesives, binders, joint cement, mastics.

9. Proposed insulation procedures and installation methods.

10. Sample data sheet of piping and valves including information contained thereon.

11. Spare parts list

12. Special tools list

C. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.

D. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.

E. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 01. Operation and Maintenance Manuals shall be submitted for all equipment.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under provisions of Division 01.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

D. Protect openings in casing and seal them with plastic wrap to keep out dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.05 SCHEDULES ON DRAWINGS

A. In general, all capacities of equipment and fixtures characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. Variations of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.

1.06 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Submit all instructions and manuals in accordance with Division 01.

1.07 CODES, PERMITS AND STANDARDS

A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.

B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.

C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Virginia Plumbing and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

1. American National Standards Institute (ANSI).

2. American Society for Testing and Materials (ASTM).

3. American Society of Mechanical Engineers (ASME).

4. Factory Mutual (FM).

5. National Electric Code (NEC).

6. Occupational Safety and Health Standards (OSHA).

7. State and local codes, ordinances and statutes.

8. Underwriters Laboratories (UL).

9. Others as designated in the specifications.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience, who issues complete catalog data on total product.

B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.

E. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

F. Plumbing fixtures shall be set and connected to drain and vent and cold and hot water supplies in a neat, finished and uniform manner. Fixtures of each class and the connection to same shall be of equal height, level and at right angles to the wall unless otherwise directed by the Engineer.

G. Each plumbing fixture shall be provided with an approved P-trap, which shall be set as close to the outlet as practicable, all water supply connections shall be provided with loose key stops.

H. Vitreous china fixtures shall be carefully selected, free from spots, grazing or chips.

I. Fixture trim, traps, faucets, escutcheons, and waste pipes that are exposed to view shall be brass with polished chromium plating over nickel finish. Exposed supplies shall be brass pipe plated in the same manner.

J. All fixtures designated for use by the disabled shall fully conform and shall be installed per the requirements of the American Disabilities Act.

K. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

L. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.01 GENERAL

A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, piping, electrical work, insulation and appurtenances ready for operation.

B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.

C. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of piping and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

D. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise.

2.02 MATERIALS

A. Pipe materials shall be in accordance with Section 15390, Schedules.

B. Underground potable cold water piping shall be copper tubing, Type “K”, 2-1/2-inch and smaller with wrought copper solder joint fittings; 3-inch and larger shall be ductile iron pipe, bell and spigot, Class 52. Fittings shall be bell and spigot, Class 250.

C. Aboveground tempered, hot and potable cold water piping shall be copper tubing, Type “L”, 3-1/2-inch and smaller with wrought copper solder joint fittings; 4-inch and larger shall be ductile iron pipe, AWWA C151, grooved or flanged ends.

D. Drain, waste, and vent piping shall be Schedule 40 PVC pipe with PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent pattern fittings solvent-cemented joints.

2.03 PIPING

A. Contractor shall form all holes; furnish and install all concrete inserts, flashings and sleeves in existing floors, walls, equipment foundations, ceilings, and roofs as required for the erection, installation, and support of all pipe and tubing.

1. Provide sleeves and flashings for all pipes and tubing, etc., furnished which passes through existing walls, intermediate floors, partition walls and roofs. Caulk wall opening with sealant in accordance with Section 07900.

2. Provide fire stopping materials which consist of commercially manufactured products capable of passing ASTM E-814 (UL 1479) Standard Method of Fire Test for Through Penetration Fire Stops wherever piping penetrates a fire rated roof, wall or floor assembly.

3. Install concrete inserts, sleeves and flashings required, as indicated, or in a manner acceptable to the Engineer.

4. All holes missed by the Contractor, but required for the installation of the piping systems, shall be made in the walls, floors, roof and by the Contractor at no additional expense to the Owner by core drilling or saw cutting methods only.

5. Provide escutcheons around pipes in all areas. Use chromium plated escutcheons on pipe penetrations exposed in finished rooms or areas. Use stainless steel escutcheons in all process areas.

B. Copper Water Tube:

1. Tube:

   a. Reference: ASTM B88.

   b. Type: K or L.

   c. Temper: Hard drawn or soft annealed.

2. Joints:

   a. General: Connect pipe with solder joints except where threaded or flanged fittings are required at valves, equipment connections or otherwise shown or directed.

3. Solder Joints: All pipe shall be reamed to full diameter before joining. Ends of pipe and inside of fittings shall be cleaned and flux applied to entire area of pipe end to be soldered. On pipe 1-1/2-inch and larger, flux shall be applied to pipe and fittings. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 “Solder Metal” Grade 95TA. Solder and flux used for piping material providing water for human consumption shall be lead free. Flux shall be non-acid, non-lead type. Remove composition discs from solder end valves during soldering. Wipe excess solder, leaving a uniform fillet around cup of fitting.

4. Fittings:

   a. Type: Wrought Copper.

   b. Reference: ANSI B16.22.

5. Unions:

   a. Reference: FS WW U 516.

   b. Material: Bronze.

   c. Rating: 250 pound W.O.G.

6. All water piping 4 inches and smaller, run within the interior of a building, shall be stainless steel in accordance with Section 15390.

C. Pipe sleeves and escutcheons:

1. Sleeves shall be provided for all piping passing through masonry or concrete walls and floors. Sleeves for walls and floors shall be indicated, made watertight and extend above floor lines. Sleeves shall conform to the requirements of Division 15.

2. Escutcheon plates shall be polished chrome. Provide for all wall penetrations in finished areas.

2.04 WATER METER

A. Water meter shall be in accordance with City of Winchester standard details. .

2.05 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventers (3/4 to 2-inch):

1. Provide reduced pressure zone backflow preventers in the size shown on the Drawings. Backflow preventers shall be rated for 175 psig and temperatures up to 140 degrees F. Backflow preventers shall be tested and certified in accordance with ASSE 1013 and AWWA C506.

2. Provide with bronze body construction, FDA epoxy coated bronze body check valve and relief valve assemblies, and bronze seats, stainless steel trim. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly.

3. Provide isolation valves on the inlet and outlet of each backflow preventer. Valves shall be quarter-turn, full port, resilient seated, bronze ball valves.

4. Provide strainer with each backflow preventers. Provide four bronze body valve test cocks.

5. Backflow preventers shall be Watts Series LF909, Wilkins, or approved equal.

2.06 WATER SERVICE BALL VALVES

A. Products and Manufacturers:

1. Watts, Series FBV-3C or FBVS-3C.

2. Nibco.

3. Or equal.

B. 2-piece full port brass ball valve.

C. NSF/ANSI Standard 61, for potable water use.

D. Sizes: 1/2” – 3”.

2.07 FIXTURE WATER STOPS

A. Products and Manufacturers: Provide stops as made by one of the following:

1. Zurn, Model Z8800 to Z8845.

2. Watts.

3. Or equal.

B. Chrome plated, solid brass with round wheel handle.

2.08 PIPE HANGERS AND SUPPORTS

A. All hangers and supports shall conform to specification section 15020.

2.09 WATER AND DRAIN PIPE INSULATION

A. Products and Manufacturers:

1. Armstrong: AP Armaflex

2. Rubatex Corp.: R-180-FS

3. IMCOA: Imcolock

4. Or equal.

B. Pipe Insulation:

1. Type: Elastomeric Closed Cell.

2. FM Approved.

3. Unit slit tubing and miter cut fittings.

4. Thickness and Application: 1/2” to 1-1/4” pipe – 3/4 inch insulation and 1-1/2” to 4” pipe – 1-inch of insulation on all water piping above slab/grade.

5. Average thermal conductivity not to exceed 0.27 (Btu-in)/(hr-FT2-°F) at mean temperature of 75° F, temperature range -40° to 220° F; permeability not to exceed 0.20 by ASTM E96; water absorption 3 percent by ASTM D1056 and ozone resistant.

2.10 PLUMBING FIXTURES

A. Provide and install plumbing fixtures and equipment specified and scheduled on Drawings. Fixtures shall bear the manufacturer's name and trademark and quality or class of fixture. All exposed piping, etc., shall be chromium plated brass. The Contractor shall check the Architectural and Plumbing Drawings for details and dimensions prior to roughing in for fixtures.

B. Stainless Steel Sink: Free standing, 14 gauge stainless steel, single bowl, tubular stainless steel legs with adjustable feet. Provide open grid strainer with tailpiece, 17 gauge chrome plated brass offset trap assembly, p-trap and supplies with loose key stops.

1. Sink:

a. Just J-127 (Basis of Design)

b. Eljer

c. Advance Tabco

d. Or equal

2. Faucet:

   a. American Standard Model 8354.112

   b. Moen Commercial Line

   c. Chicago faucet

   d. Or equal

3. P-Traps:

   a. American Standard

   b. Eljer

   c. Kohler

   d. Or equal

D. Instantaneous (tankless) water heater.

1. Tankless Water Heater shall be 480V, single-phase to heat 3.0 GPM @ a temperature rise of 48 degrees F. Unit shall have ABS-UL 94V0 rated cover. Element shall be replaceable cartridge insert. Unit shall have a replaceable filter in the inlet connector and a flow regulator in the outlet connector.

2. Element shall be iron free, nickel chrome material.

3. Heater shall be fitted with 1/2-inch compression nuts and sleeves to eliminate need for soldering.

4. Hot water storage tanks prohibited.

5. Unit shall be Eemax Model ED024480T2T, or equal.

2.11 GASKETS AND CONNECTORS

A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.

B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

C. Furnish all bolts, studs, nuts and fasteners for make-up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 3 - EXECUTION

3.01 POTABLE WATER SYSTEMS

A. Pipe shall be installed according to Section 15000, Basic Mechanical Requirements and in accordance with Drawings.

B. Provide cold and hot water supply systems in the buildings as indicated, making connections to all fixtures and equipment requiring hot and/or cold water.

C. Underground Pipe

1. The piping shown on the Drawings shall be installed complete and shall be of the size shown. Where pipe passes close to or through walls or footings, it shall be protected from contact with concrete or cinder block. All pipe passing through building walls shall be protected by a cast iron sleeve large enough to permit free movement of pipe. Where pipe passes through a building wall from underground to inside building, the sleeve shall be packed with oakum and made watertight.

2. All copper pipe shall be installed in such a manner that it does not bear directly on rocks or debris in ground. All turns shall be made with a gradual curve so there is no chance of kinking or collapsing the pipe. Where copper pipe cross deeper excavations, these shall be filled and tamped to the proper level before copper pipe is installed.

3. Install underground PVC waste piping according to ASTM D 2321, and ASTM F1668 and in accordance with Section 15000, Basic Mechanical Requirements and Drawings. Install buried piping connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

4. Pipe Depth

a. Interior: Water pipe shall NOT be permitted inside concrete slabs.

b. Exterior: the water pipe shall have a minimum of 4 feet of cover and shall comply with state and local codes.

D. Aboveground Pipe:

1. The piping shown on the Drawings shall be installed complete and shall be of the size shown. All piping shall be installed to allow for expansion, either parallel or perpendicular to the building construction.

2. Pipe shall be supported in accordance with Section 15020, Pipe Supports.

3. Where pipes pass through walls and suspended ceilings, provide pipe sleeves of No. 20 gage galvanized iron, 1/2 inch larger than insulated pipe or bare pipe outside diameter.

4. Pipe passing through floors and foundation shall be provided with sleeves of standard weight galvanized steel pipe. Sleeves shall be at least 1 inch larger than bare pipe and 1/2 inch larger than insulated pipe outside diameter. Ends shall be cut square and smooth and finish flush with surface of building construction. Where specifically noted, ends shall extend 1 inch above floor and

edges chamfered.

5. Pipe sleeves shall be securely bedded in the building construction. Sleeves shall finish flush with finished wall and ceiling lines. Note that where covering is provided, it shall extend continuously through sleeves.

6. Sleeves installed in vertical positions shall be perfectly plumb and sleeves in horizontal positions shall be level. They shall be located, set, and maintained in position while surrounding construction work is being installed so that the center of each pipe shall be accurately installed in the center of the sleeve. The space between the pipe or the insulation and the sleeve shall be caulked to prevent light or air transfer. Where vertical sleeves occur, such as in floors or ceilings, special collars secured to the pipes or to the ceiling construction shall be provided to prevent the packing from falling out. The standard floor and ceiling plates herein specified for finished areas may be used for this purpose provided they are firmly secured to the pipes.

7. Pipe Insulation shall be continuous through wall, floor and ceiling penetrations and at all supports. Insulation through penetrations shall be pack insulation around pipes with fireproof self-supporting mineral wool insulation material, fully sealed.

   a. Insulation for cold piping: Insulate all fittings, including flanges, all valve bodies and devices associated with cold surfaces. Maintain vapor barrier integrity.

   b. Finish insulation neatly at hangers, supports and other protrusions or interruptions.

   c. Ensure hangers and cradles are properly installed to avoid crushing insulation.

   d. Install protective metal saddles and insulated inserts to prevent insulation compression.

   e. Insulate all exposed piping below fixtures scheduled for use by the disabled in accordance with ADA with pre-formed insulation kits by Truebro Lavguard 2E-Z, or equal.

3.02 ROOF VENTS

A. Roof stack terminals shall be flashed using elastomeric cones with base.

3.03 PLUMBING FIXTURES

A. After plumbing fixtures have been installed, fixtures and trim shall be thoroughly cleaned of all grease, oil, dirt, labels, stickers, and other foreign matter, and all packing materials shall be promptly removed from the premises. All valves and faucets shall be adjusted to suit the operating water pressure and all work maintained in clean and proper operating condition until accepted by the Engineer.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drain piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

G. Installation of the plumbing fixtures and accessories shall meet the applicable requirements of the American with Disabilities Act (ADA).

H. Install air gap fitting for reduced pressure backflow devices. Route drain piping from outlet of air gap to the interior drain piping.

I. Install faucet, flow-control fittings with specified flow rates and patterns.

J. Install traps on fixture outlets.

K. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 for sealant and installation requirements.

3.04 TESTING

A. Notify Owner and Engineer one week in advance that the items are ready for testing.

1. Perform testing before work is concealed with construction or insulation, or before backfilling if piping is to be buried.

a. Concealed piping shall be installed in time so as not to delay work of other trades and to allow ample time for tests and inspection.

B. Test pressures shall be in accordance with ANSI B31.1 Code for Pressure Piping, Paragraphs 121(a), (b), and (c).

1. Test pressures shall be in accordance with Section 015930, Schedules.

2. All tests shall be held for at least 4 hours and until each joint has been inspected.

3. At conclusion of testing remove special test fittings, caps, blanking plates, etc. and replace damaged gaskets and place systems in operation.

C. If inspection or tests show defects or failure, such defective work, materials or failure shall be replaced without delay and inspection and tests repeated. Repairs to piping and equipment shall be repaired or replaced with new material or equipment. Caulking of screw joints or plugging leaks shall not be permitted.

D. Tests for each section shall be repeated at no additional cost to the Owner until the

piping is proven tight at the specified test pressure. Upon completion of work, inspection shall be made by the Engineer. All corrections, changes or removal of defective work shall be made by the Contractor at no cost to the Owner

E. Water and Drain Pipe Testing: Shall be hydrostatic tested as follows, except where more stringent tests are required by the codes.

1. Slowly fill with water each valved section in pipe and apply the specified test pressure by means of a portable positive displacement pump connected to the piping in an acceptable manner.

2. Make taps if necessary, at points of highest elevation, and plug tightly afterwards.

3. Carefully examine all exposed pipe, fittings, valves and joints during the tests.

4. Where joints show seepage or slight leaks repair as requested.

5. Remove and replace any cracked or damaged pipe, fittings, valves, or other defective materials discovered during the test.

6. After replacements and repairs have been made, repeat tests until work is satisfactory and approved.

F. All drainage and vent piping shall be tested before fixtures are installed, by capping or plugging the openings and filling the entire system with water and allowing it to stand thus filled for three hours.

G. All water supply piping shall be tested before fixtures or faucets are connected.

H. Each fixture shall be tested for soundness, stability of support and satisfactory operation of all its parts.

I. Disinfection of potable water systems shall be performed in accordance with the procedures described in AWWA C651 or AWWA C652.

3.05 CLEANING

A. Clean dirt and marks and other debris from exterior of equipment weekly.

B. Remove debris and waste material resulting from installation weekly.

C. Properly protect all plumbing fixtures and trim at all times and temporarily close all openings to prevent obstruction and damage.

D. Maintain protective covers on all units until final clean-up time and, at that time, remove covers, clean and polish all fixture and trim surfaces.

- END OF SECTION -

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SECTION 15500

BASIC HVAC REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, equipment, and materials for the complete installation of the heating, ventilation, and associated appurtenances including but not limited to piping, controls, drain lines, conduits and wire, etc. as indicated on the Contract Drawings and specified herein.

1.02 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical, and ventilation work required, all in accordance with the requirements of Section 01300, Submittals.

B. Data to be submitted shall include but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete assembly, and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.

3. Weight of all component parts and assembled weight.

4. Electrical characteristics, wiring, diagrams, etc.

5. Sample data sheet of equipment nameplate(s) in accordance with the requirements of Section 11000, Equipment General Provisions.

6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.

7. Details of special fasteners and accessories.

8. Type of adhesives, binders, joint cement, mastics.

9. Proposed insulation procedures and installation methods.

10. Spare parts list

11. Special tools list

C. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests in accordance with Section 01300, Submittals.

D. The Contractor shall obtain from the manufacturer and submit to the Engineer certifications of compliance in accordance with Section 01300, Submittals.

1.03 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

B. Operation and Maintenance Manuals shall be submitted for all equipment.

1.04 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's instructions.

B. All changes from the installation procedures in manufacturers' data shall be submitted to the Engineer and Owner for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Submit all Operation and Maintenance Manuals with the requirements of Section 01300, Submittals.

1.05 CODES, PERMITS AND STANDARDS

A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.

B. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Uniform Plumbing Code, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

C. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

Air Conditioning and Refrigeration Institute (ARI)
Air Diffusion Council (ADC)
Air Moving and Conditioning Association (AMCA)

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
American National Standards Institute (ANSI)
American Society for Testing and Materials (ASTM)
American Society of Mechanical Engineers (ASME)
Factory Mutual (FM)
National Electric Code (NEC)
NFPA 90A - Air Conditioning and Ventilation Systems
Occupational Safety and Health Standards (OSHA)
Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
Standard Building Code - 1985 edition
Standard Mechanical Code - 1985 edition
Standard Plumbing Code - 1985 edition
State and local codes, ordinances and statutes
Underwriters Laboratories (UL)
and others as designated in the specifications.

1.06 QUALITY ASSURANCE

A. All material and equipment shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

B. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

C. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.

D. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

1.07 IDENTIFICATION MARKERS

A. Provide manufacturer's standard laminated plastic, color coded duct markers. Color shall be selected by the Owner:

B. Indicate service and direction of flow on all ducts.

1.08 GASKETS AND CONNECTORS

A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.

B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

C. Furnish all bolts, studs, nuts and fasteners for make-up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.

B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.

C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial-commercial grade.

D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located, otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.

E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.

G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring-type vibration isolators.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15598

DUCTWORK AND DUCT ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all ductwork, fittings, and accessories as shown on the Drawings and in accordance with the Specifications.

B. The equipment shall be furnished complete with all accessories, special tools, spare parts, base attachments, mountings, anchor bolts and other appurtenances as specified or as may be required for a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15000 - Basic Mechanical Requirements

B. Section 15500 - Basic HVAC Requirements

C. Section 15990 – HVAC Testing, Adjustment, and Balancing

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all new and modified ductwork, accessories and appurtenances and all fabrication work required for all equipment specified in this section in accordance with Section 01300, Submittals.

B. Shall be as specified in Section 15500, Basic HVAC Requirements.

C. Shop Drawings: CAD-generated and drawn to no less than 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation. Include plans, elevations, sections, components, and attachments to other work.

2. Duct layout. Indicate sizes and pressure classes.

3. Elevations of ducts.

4. Dimensions of main duct centerlines from building grid lines.

5. Fittings. Indicate fitting types.

6. Reinforcement and spacing.

7. Seam and joint construction.

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8. Seal classes.

9. Penetrations through fire-rated and other partitions.

10. Equipment installation based on equipment being used on Project.

11. Duct accessories, including access doors and panels.

12. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

1.04 WARRANTY

A. All warranties shall be per Section 11000, Equipment General Provisions.

PART 2 --PRODUCT

2.01 GENERAL REQUIREMENTS

A. All work shall be constructed and installed in a first class workmanlike manner in accordance with the recommendations given in the latest edition of the Sheet Metal & Air Conditioning Contractors National Association (SMACNA) Rectangular Industrial Duct Construction Standards and Round Industrial Duct Construction Standards, unless otherwise specified.

B. All ductwork shall be constructed in accordance with the Duct Construction Schedule located in Part 3 of this specification. Transverse duct connections shall be bolted, gasketed connections.

C. All ducts shall conform accurately to the dimensions indicated on the Drawings, shall be straight and smooth on the inside with neatly finished joints, and shall not be decreased at any point to avoid obstructions. No piping, conduit or structural work shall be installed in or through any ductwork. All ductwork shall be run as close as possible to structural members, walls and ceilings. Ductwork shall be as shown on the Drawings, subject to such modifications as may be necessary to suit field conditions.

D. Where existing walls, floors or roofs must be penetrated, the Contractor shall neatly cut the required openings and patch the existing work to provide a neat and finished appearance.

E. All ducts shall have no openings other than those required for the proper operation and maintenance of the systems.

F. Minimum thickness for metal ducts shall be per SMACNA guidelines but in no instance shall be less than 20 gage for steel and 14 gage for aluminum ducts.

G. Supports for ducts shall be provided and securely fastened in place at every change in direction and as required to prevent deflection.

H. Changes in size of ducts shall be by means of a taper transformation piece, the included angle of the taper being not more than 20 degrees.

I. All ductwork joints shall be sealed to achieve a SMACNA Seal Classification Rating as indicated in the Duct Construction Schedule located in Part 3 of this specification.

J. The weight of material used for ducts and stiffeners, the fabrication methods, cross breaking of flat duct surfaces, and assembling of the ductwork shall conform to the Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. Beaded duct construction shall not be used.

K. All duct panels shall be braced or reinforced as necessary, in addition to the minimum requirements in the ASHRAE Guide, to eliminate vibration and noise and to prevent deflection from the indicted shapes and dimensions.

2.02 STAINLESS STEEL AND ALUMINUM DUCT

A. Ductwork material shall be as indicated in the Duct Construction Schedule located in Part 3 of this specification.

B. Stainless Steel: ASTM A 480/A 480M, Type 316 having a number 2D finish for all ducts and of adequate strength and rigidity to meet the conditions of the service and installation requirements, and shall be properly protected where subject to mechanical injury.

C. Aluminum: ASTM B209, alloy 1100, 3003, or 5052 for all applicable ducts and of adequate strength and rigidity to meet the conditions of the service and installation requirements and shall be properly protected where subject to mechanical injury.

D. Transverse duct connections for rectangular ducts shall be bolted, gasketed connections made with standard Ductmate 35 System as manufactured by Duct Mate Industries, W.D.C.I. or approved equal. All longitudinal seems shall be Pittsburg Z, or better. Duct connections shall match the duct material. Gaskets shall be suitable for exposure to hydrogen sulfide.

E. Transverse duct connections for round ducts shall be bolted, gasketed connections in accordance with chapter 12 of SMACNA Round Industrial Duct Construction Standards. Duct connections shall match duct material. Utilize longitudinal seam ductwork. Gaskets shall be suitable for exposure to hydrogen sulfide and outdoor use.

F. All ductwork shall be shop fabricated in sections with flanged ends. The flange system shall be factory spot welded to the ductwork. No field welding of ductwork shall be permitted. Welding equipment and electrodes shall be of a type specifically suited for welding light gauge Type 316 stainless steel or aluminum to provide consistently good quality welds.

G. All duct sections shall be constructed and installed without forming dips and traps.

H. Dampers in exhaust ducts shall be specifically listed and approved for such use.

I. All ducts shall have a minimum clearance of three (3) inches from all combustible material.

2.03 HANGERS AND SUPPORTS

A. All ductwork shall be securely hung and anchored to the building structure. Unless otherwise shown or specified, hangers and stiffeners for ducts shall conform with the recommendations given in the SMACNA HVAC Duct Construction standards and SMACNA seismic restraint manual.

B. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall be stainless steel. Neoprene pads shall be utilized to isolate the dissimilar metals in the duct and its supports and associated hardware.

C. All ductwork shall be supported from trapeze type hangers. Stainless steel hanger rods shall be minimum 3/8 inch for all ducts with half perimeter up to 72 inches, and ½ inch diameter for all ducts with half perimeter larger than 72 inches. A pair of rods shall be provided at each duct support point. Maximum hanger spacing shall be 8 feet for ducts with half perimeter up to 72 inches and 6 feet for ducts with half perimeter larger than 72 inches.

D. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.

E. Support shall be furnished at each fitting. Material of supports shall match duct material.

F. Seismic Requirements: All piping and ductwork shall be provided with seismic restraints in accordance with the Seismic Restraint Manual, Guidelines for Mechanical Systems, as published by SMACNA, in accordance with the Virginia Building Code, and ASCE-7 to the extent that the most stringent provisions are utilized. Material of seismic restraints shall match duct material.

2.04 ACCESSORIES

A. Manual Volume Dampers in Stainless Steel or Aluminum Duct:

1. Manufacturer: Provide products of one of the following:

a. Greenheck

b. Ruskin

c. Or equal

2. Frame, blade, axle, bearings, jamb seal, and linkage materials: Match ductwork.

3. Blades:

a. Opposed blades for volume dampers and parallel blades for backdraft dampers;

b. Vinyl edge seals, thermoplastic elastomer seals for corrosive/chemical services.

4. Damper shafts shall be solid hexagonal or square shape.

5. Linkage shall be concealed in damper frame.

6. Provide outside handle, quadrant and approved position indicator and locking device.

7. Reference: SMACNA Standards.

B. Stainless Steel Motorized Dampers:

1. Manufacturer: Provide products of one of the following:

a. Ruskin

b. Greenheck

c. Or equal

2. Frame, blade, axle, bearings, jamb seal, and linkage materials: 316 Stainless Steel.

3. Blades:

a. Opposed blades (control) and Parallel blades (shut-off)

b. Vinyl edge seals, thermoplastic elastomer seals for corrosive/chemical services.

4. Actuators shall be externally mounted to the damper and shall be a minimum of NEMA 2. All actuators shall be enclosed in a NEMA 4X case unless otherwise specified. See section 15950-HVAC Electric Control Systems for actuator requirements.

5. Reference: SMACNA Standards.

6. Damper shafts shall be solid hexagonal or square type.

C. Aluminum Motorized Dampers:

1. Manufacturer: Provide products of one of the following:

a. Ruskin

b. Greenheck

c. Or equal

2. Frame, blade, axle, bearings, jamb seal, and linkage materials: 6063T5 Aluminum

3. Inside and outside of all parts shall be coated with a corrosion resistant coating. The coating shall be Kynar 500 or equal.

4. Blades:

a. Opposed blades (control) and Parallel blades (shut-off)

b. Neoprene blade edge seals and flexible metal compressible jamb seals.

5. Actuators shall be externally mounted to the damper and shall be a minimum of NEMA 2. All actuators shall be enclosed in a NEMA 4X case unless otherwise specified. See section 15950 for actuator requirements.

6. Reference: SMACNA Standards.

7. Damper shafts shall be solid hexagonal or square shape.

D. Combination Louver/Dampers:

1. Manufacturer: Provide products of one of the following:

a. Ruskin

b. Greenheck

c. Equal

2. Frame, blade, axle, bearings, jamb seal, and linkage materials: 6063T5 Aluminum

3. Inside and outside of all parts shall be coated with a corrosion resistant coating. The coating shall be Kynar 500 or equal.

4. Frame shall be 0.125 inches thick

5. Front Blades:

a. Drainable with minimum wall thickness of 0.081 inch

b. Blades shall be angled at 37 degrees

6. Rear Blades:

a. Double wall airfoil shape with minimum wall thickness of 0.14 inch

b. Linkage shall be concealed in the frame

c. Bearings shall be stainless steel

d. Axles shall be stainless steel

7. Seals:

a. Blade edge seals shall be extruded vinyl

b. Jamb seals shall be compressible type of aluminum construction

8. Drain gutters shall be in head frame and each blade

9. Downspouts in jambs shall drain water from louver

10. Provide aluminum bird screens. Screens shall be expanded and flattened type.

E. Stationary Louvers:

1. Manufacturer: Provide products of one of the following:

a. Ruskin, model ELF6375DX with CBD@ counter balanced backdraft damper

b. Greenheck

c. Or equal

2. Frame, blade, axle, bearings, jamb seal, and linkage materials: 6063T5 Aluminum

3. Inside and outside of all parts shall be coated with a corrosion resistant coating. The coating shall be Kynar 500 or equal.

4. Frame shall be 0.125 inches thick

5. Blades:

a. Drainable with minimum wall thickness of 0.081 inch

b. Blades shall be angled at 37 degrees

6. Seals:

a. Blade edge seals shall be extruded vinyl

b. Jamb seals shall be compressible type of aluminum construction

7. Drain gutters shall be in head frame and each blade

8. Downspouts in jambs shall drain water from louver

9. Provide aluminum bird screens. Screens shall be expanded and flattened type.

F. Sheet Metal Safing: Provide sheet metal safing of the same material as the duct, to close off and seal airtight all unused areas behind louvers.

G. Screens: ½-inch (13 mm) mesh, material shall match duct material, framed with bolt holes unless indicated otherwise.

H. Registers and Grilles:

1. Manufacturer: Provide product(s) of one of the following:

a. Titus

b. Anemostat

c. Nailer Industries, Inc.

d. Or Equal

2. Units shall be factory-fabricated of Type 316 stainless steel construction for stainless steel and FRP ductwork and aluminum for aluminum ductwork. They shall distribute the specified air volume (cubic feet per minute).

3. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance.

4. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers.

5. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling.

6. An additional volume damper shall be installed in duct stub to each air outlet for balancing of air volume.

7. Supply Registers:

a. Supply registers shall be double deflection type, complete with adjustable vertical face bars and a key operated opposed blade damper.

b. Supply registers installed in stainless steel and FRP ductwork shall be of Type 316 stainless steel double deflection type complete with opposed blade stainless steel damper.

8. Air extracting devices shall be installed at all collar take-offs to supply registers. The air extracting devices shall have two sets of individually adjustable blades to

equalize flow and control volume at collar takeoffs and shall be gasketed around the perimeter.

9. Exhaust and Return Registers and Grilles:

   a. Exhaust and return registers shall be furnished with fixed vertical face bars, set straight, and a key operated opposed blade damper.

I. Duct-Mounted Access Doors and Panels:

   1. Provide access doors at all duct connections to wall louvers for access and maintenance of louver motor actuators and linkages.

   2. Fabricate doors and panels airtight and suitable for duct pressure class.

   3. Seal around frame attachment to duct and door to frame with neoprene.

   4. Door and frame to be of same material as duct.

   5. Access doors and panel shall be made as large as practical given duct dimensions.

J. Flexible Connectors:

   1. Self-extinguishing material shall meet NFPA 90A, NFPA 701 and UL-214 Standards.

   2. Material:

      a. Commercial grade neoprene coated woven fiberglass, Proflex by DUCTMATE, or equal.

      b. Corrosion/chemical resistant applications shall be of Teflon coated woven fiberglass fabric. Minimum density 18 oz./sq. yd. and rated to 500 degree F.

   3. Extra wide metal edge connectors factory fabricated with a strip of fabric attached to two strips of 0.028-inch-thick, 316 stainless steel sheets.

K. Instrument Test Holes: Materials shall match duct material, including screw cap and gasket. Size holes to allow insertion of pitot and other testing instruments, and length to suit duct insulation thickness.

L. Turning Vanes:

   1. Turning vanes shall be double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically.

2. Tab spacing shall be as specified in Figure 2-3 of the 1995 SMACNA Manual, “HVAC Duct Construction Standards, Metal & Flexible” Second Edition standard. Rail systems with non-standard tab spacing shall not be accepted.

3. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer’s instructions.

4. The material of turning vanes shall be the same material as the ductwork in accordance with SMACNA standards.

PART 3 --EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling.

B. Prevent end damage and prevent dirt and moisture from entering ducts and fittings. Where possible, store ductwork inside and protect from weather. If necessary to store outside, store above grade and enclose with waterproof wrapping.

3.02 INSTALLATION OF DUCTWORK

A. Examine areas and conditions under which ductwork is to be installed. If the Installer deems the space unfit for ductwork installation, all installer indicated issues shall be remedied prior to installation of the ductwork.

B. Assemble and install ductwork in accordance with recognized industry practices and Manufacturer’s installation instructions, and SMACNA standards to achieve the seal and leakage classes indicated in the Duct Construction Table at the end of this specification section.

C. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.

D. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.

E. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

F. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment.

G. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 3" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where

possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings.

H. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

I. Turning vanes shall be installed in all miter elbows to permit air to make the abrupt turns with a minimum of turbulence. The turning vanes shall be quiet and free from vibration when the system is in operation. Vanes shall be installed in all short radius elbows in accordance with SMACNA standards and Industrial Duct Construction standards.

J. The dial regulators shall be marked so that the "open" and "shut" positions are clearly identified. The dial regulators on insulated ductwork shall be mounted on an elevated platform which will finish flush with the surface of the insulation. Manual volume dampers shall be located at accessible points and wherever possible some distance from a duct transition or fitting. Care shall be taken during installation to make certain that sheet metal fasteners do not protrude into the duct and interfere with damper operation. Dampers shall be provided in each branch duct take off and in both ducts downstream of each trunk duct split.

K. Test openings shall be installed in the ductwork at the points listed below. The openings shall be sealed by a screw cap and gasket, and shall be installed so that the insulation is not disturbed when the cover is removed. The test openings shall be located as follows in all heating, ventilating, air conditioning systems, and dehumidification systems:

1. Upstream and downstream of each coil

2. In the outside air duct adjacent to the unit

3. In the return air duct adjacent to the unit

4. In the main supply duct on single zone units and in each zone supply duct on multizone units upstream and downstream of each filter bank

5. Upstream and downstream of each filter bank.

6. As indicated on the Contract Drawings

L. Air filter gauges for measuring the differential pressure through all filter banks s and duct mounted filters shall be supplied and installed; one gauge shall be installed for each bank. The gauge shall be of the inclined tube differential type complete with 1" thick acrylic plastic body, mirror-polished scale, built-in level vial, over pressure safety traps, signal flags, 2 vent valves for zeroing gauge, 2 static pressure tips, two 5-foot lengths of 1/4" stainless steel tubing, 2 compression fittings, mounting hardware, a bottle of red gauge oil and instructions. The gauges shall have a range of 0-1.0 inch water column with minor divisions of .02 inch water column.

M. The Contractor shall install prefabricated roof curbs before the installation of roofing.

N. All air outlets shall be with rigid connection to the ductwork.

O. After the installation is completed, the Contractor shall seal all joints air tight. Sealants and tape shall have a flame spread not greater than 25 and a smoke developed rating of not over 50 per ASTM E-84.

3.03 INSULATION INSTALLATION

A. Insulation shall be installed on all outdoor ductwork carrying conditioned air, all ductwork carrying conditioned air through unconditioned spaces, and all ductwork carrying unconditioned air through conditioned spaces. Conditioned air is any air that has received any heating, cooling, or dehumidification from HVAC equipment. Conditioned spaces are any spaces that receive conditioned air. Return and exhaust ductwork serving a conditioned space is considered conditioned air.

B. Ductwork carrying cooled conditioned air passing through spaces that only receive heated conditioned air shall be insulated. Ductwork carrying cooled air for spaces that require year round cooling such as electrical rooms, shall be insulated when passing through spaces that are provided heated conditioned air during the heating season.

C. Follow manufacturer's installation instructions and recommended adhesives. The installation method shall provide a continuous vapor barrier.

D. The insulation vapor barrier shall be maintained through all supports, flanges, reinforcement, and penetrations. Where the duct weight would deform the insulation material at supports, the Contractor shall use fiberglass insulation blocks. The blocks shall be the same thickness as the insulation. The vapor barrier shall be maintained using a system approved by the insulation manufacturer for spanning the insulation block.

3.04 EQUIPMENT CONNECTIONS

A. Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.05 ADJUSTING AND CLEANING

A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration. Adhere to requirements of SMACNA document "Duct Cleanliness for New Construction Guidelines".

B. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

DUCT CONSTRUCTION SCHEDULE				
SERVICE	*PRESSURE CLASSIFICATION*	*DUCT MATERIAL*	*SEAL CLASS*	*CONSTRUCTION STANDARDS*
All ductwork in valve vault	+/- 3 in wg.	Aluminum	B	SMACNA Rectangular Industrial Duct Construction Standards

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SECTION 15750

PACKAGED AIR CONDITIONING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. These specifications describe requirements for a precision environmental control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements of the room and accessories. Refer to schedules for applicable equipment features.

B. All necessary accessory equipment and appurtenances shall be provided for a complete and operating system whether or not specifically stated in the Specifications. This installation shall incorporate the highest standards for the type of service shown on the Drawings included field testing of the entire installation and instruction of the regular operating personnel in the care, operation, and maintenance of all equipment.

C. The equipment shall be furnished complete with all accessories, special tools, spare parts, extra set of filters, and other appurtenances as specified or as may be required for a satisfactory installation.

D. Work Included Under Other Sections:

1. 480V, 3-phase power wiring and conduit under Division 26, Electrical.
2. Motor starters under Division 16, Electrical, unless factory mounted and wired by equipment manufacturer

1.02 RELATED SPECIFICATIONS

A. Section 01300 - Submittals

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

D. Protect openings in casing and seal them with plastic wrap to keep out dirt and debris.

1.04 SCHEDULES ON DRAWINGS

A. In general, all capacities of equipment and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.

1.05 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Submit all instruction books and manuals in accordance with Division 1.

1.06 CODES, PERMITS AND STANDARDS

A. The contractor shall obtain and pay for all permits (unless specifically excluded under Division 1 requirements) and shall comply with all laws and codes that apply to the work.

B. The Contractor shall be responsible for all added expenses due to his choice of equipment, materials or construction methods.

C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the State Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

1. American Society of Mechanical Engineers (ASME)
2. American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE)
3. American National Standards Institute (ANSI)
4. American Society of Testing and Materials (ASTM)
5. Air Movement and Control Association (AMCA)

6. Air-conditioning, Heating and Refrigeration Institute (AHRI)

7. National Fire Protection Association (NFPA)

8. National Electrical Code (NEC)

9. International Mechanical Code

10. Underwriters Laboratories (UL)

11. Applicable Federal, State and local laws and/or ordinances

E. Where conflict arises between the local codes and the requirements of the National Electrical Code, The National Fire Code, NEMA, ASTM, etc., the more stringent requirements shall prevail.

1.07 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Division 1 the Contractor shall obtain from the equipment manufacturer and submit the following:

1. A list of all Contract deviations and non-applicable requirements. Those applicable Contract requirements that are not listed explicitly as deviations shall be deemed by the Contractor as being in total compliance with the Contract requirements. The Contractor is responsible for and will make any and all changes to installed equipment that does not comply with the Contract. Such changes shall be made at no additional cost.

2. Shop Drawings

3. Operation and Maintenance Manuals

4. Special Tools List

5. Reports of Certified Shop Tests

6. AMCA Approval of Fan Ratings

B. Each submittal shall be identified as specified in the General Conditions and Division 1.

C. Shop Drawings:

1. Each submittal shall be complete in all aspects incorporating all information and data listed herein and all additional information required to evaluate the proposed piping material's compliance with the Contract Documents. Partial or incomplete submissions shall be returned to the Contractor disapproved without review.

2. Partial, incomplete or illegible submissions will be returned to the Contractor without review for resubmittal.

3. Shop drawings shall include but not be limited to:

4. Equipment specifications and data sheets identifying all materials used and methods of fabrication.

5. Complete assembly, layout, installation drawings with clearly marked dimensions.

6. Computer printout for coil selection.

7. Interconnecting wiring diagram.

8. Motor name plate data

9. Example equipment nameplate data sheet.

D. Operations and Maintenance Manuals

1. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

2. One electronic copy of a preliminary O&M manual shall be included in the shop drawing submittal.

1.08 SPARE PARTS AND SUPPLIES

A. Furnish all special tools necessary to dissemble, service, repair and adjust the equipment.

B. The following spare parts shall be furnished with each unit specified, as applicable per the Contract Drawings. Refer to schedule for applicable features:

1. Two (2) sets of Pleated Filters

2. One (1) sets of Match V-Belts

3. One (1) Temperature Sensor

4. One (1) Cans of 18oz. Spray-on Touch-Up Paint

C. Furnish additional spare parts as recommended by the equipment manufacturers.

D. Spare parts lists, included with the drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as “1 lot of packing material” are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.09 QUALITY ASSURANCE AND QUALIFICATIONS

A. The equipment covered by these specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. In conformance with Article 5 of the General Conditions, equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and as shown on the Contract Drawings.

B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.

E. Touch up and/or repaint to match original factory finishes for all finished or painted equipment and materials which are scratched or marred during shipment or installation.

F. Factory Authorized Start-Up Services: The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and field testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation.

1.10 SPECIAL TOOLS

A. Furnish all special tools necessary to dissemble, service, repair and adjust the equipment.

PART 2 -- PRODUCTS

2.01 TYPE I – THROUGH WALL MOUNTED

A. Subject to compliance with requirements of the Contract documents provide precision control air conditioning unit(s) manufactured by one of the following:

1. Marvair Comc I: AVPA20 AC D 050 N R A5 (Basis of Design)

2. Bard

3. or Equal

B. The Control Room Air Conditioning System shall be a self-contained factory assembled units. The system shall have the following built-in components:

1. Cabinet and Frame Construction: The cabinet and frame shall be constructed of aluminum. The exterior panels shall be insulated with a minimum 1", 3 lbs. Density fiberglass thermal and acoustical insulation.

2. Filter Chamber: The filter chambers shall be an integral part of the system, located within the cabinet serviceable from the inside of the room. The filters shall be rated with a minimum MERV 8 unless otherwise indicated on the Contract Drawings.

3. Evaporator Fan Section: The fan shall be the centrifugal type, backward inclined and shall be statically and dynamically balanced as a completed assembly to a

maximum vibration level of two mils in any plane. The shaft shall be heavy duty stainless steel with self-aligning ball bearings with a minimum L-10 life span of 100,000 hours. The fan motor shall be 1750 RPM or less and mounted on an adjustable slide base. The drive package shall be two-belt, variable pitched, sized for 200 percent of the fan motor horsepower. The fans shall be located to draw air over the A-Frame coil to ensure even air distribution and maximum coil performance.

4. Control System: The control system shall be microprocessor based. Unit-mounted panel with main fan contactor, compressor contactors, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- // and humidity // -control modules // humidity contactor //, time-delay relay, heating contactor, and high-temperature thermostat. The display and housing shall be viewable while the unit panels are open or closed. The controls shall be menu driven. The display shall be organized into three main sections: User Menus, Service Menus and Advanced Menus. The system shall display user menus for: active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in % of each function, date and time), total run hours, various sensors, display setup, and service contacts. A password shall be required to make system changes within the service menus. Service menus shall include: set-points, standby settings (lead/lag) timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode. A password shall be required to access the advanced menus, which include the factory settings and password menus. Menu shall allow the set-points within the following ranges:

   a. Temperature Set-point: 65-85ºF

   b. Temperature Sensitivity: +1-10ºF

   c. High Temperature Alarm: 35-90ºF

   d. Low Temperature Alarm: 35-90ºF

5. Refrigeration System: The refrigeration system shall consist of compressor, condenser coil, evaporator coil, expansion valves and service valves. Unless indicated otherwise in the equipment schedule, compressors shall be scroll type:

   a. Scroll Compressors: The compressor shall be scroll-type. The compressor shall be suction gas cooled motor, vibration isolators, thermal overloads, automatic reset high pressure switch with lockout after three failures, service valves, pump down low pressure transducer, suction line strainer and a maximum operating speed of 3500 RPM.

   b. All compressors shall be furnished with electric crankcase heaters.

   c. D.X. Coil: The evaporator coil shall be a minimum of 3 rows deep. It shall be constructed of copper tubes and aluminum fins. A stainless steel condensate drain pan shall be provided. When indicated on the Contract Drawings, the coil shall be provided with a Heresite corrosion resistant

coating. The Heresite coating shall have a UV resistant top coat. Blygold coating is an acceptable alternative.

6. Smoke Detector: The smoke detector shall immediately shut down the environmental control system and activate the alarm system when activated. The smoke detector shall be mounted in the control panel with the sensing element in the return air compartment. The smoke sensor is not intended to function as or replace any room smoke detection system that may be required by local or national codes. The smoke sensor shall include a supervision contact closure.

7. Motors: The motors shall be of the high premium efficiency totally enclosed fan cool type with built-in overload protection.

C. Air Cooled Condensing Unit (Integral to AC Unit)

1. The air-cooled condensing unit shall be contained within the Air Conditioning Unit and shall not require any additional refrigeration piping. The system shall be designed for 95oF ambient unless otherwise noted on the Contract Drawings.

2. The control system for the air cooled condensing unit shall be constant fan speed control unless indicated otherwise in the Contract Drawings. The fan speed control condensing unit shall have a fan speed controller sensing refrigerant pressure and varying the speed of the fan speed control duty motor. If condensing unit has more than one fan, any additional fan motors shall be fixed speed, cycled On/Off by ambient air thermostats to further vary flow across the coils. The fan speed control system shall provide positive startup and operation in ambient temperatures as low as -20oF.

3. Condensing unit coils shall be constructed on copper tubes on a staggered tube pattern. Tubes shall be expanded into continuous, rippled aluminum fins. The fins shall have full-depth fin collars completely covering the copper tube. Copper tubes shall be connected to heavy wall type 2 headers, inlet coil connector tubes shall pass through relieved holes in the tube sheet, for maximum resistance to piping strain and vibration. Coils shall be factory leak-tested at 400 psig (minimum); dehydrated, evacuated and charged.

4. Fans shall have aluminum blades. Fan shall be secured to fan shaft by means of a heavy-duty keyed hub and dual set screws. Fans shall be factory balanced and run before shipment.

5. When indicated on the Contract Drawings, the air cooled condensing unit coils shall be provided with a Heresite corrosion resistant coating. The Heresite coating shall have a UV resistant top coat. Blygold coating is an acceptable alternative.

D. When corrosion resistant coating is required for the evaporator and condensing unit coils, all copper piping inside the condensing and evaporator units but external to the coils shall also be coated with a corrosion resistance coating. A spray on coating such as Incralac, Heresite, Blygold, or equivalent shall be used. The coating shall provide long-term protection in a hydrogen sulfide (3 ppm) operating environment. The Heresite coating shall have a UV resistant top coat.

E. Controller shall be provided with 2 sets of remote alarm contacts and 2 sets of shutdown contacts.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Air conditioning unit shall be installed, connected and placed in satisfactory working order in accordance with the manufacturer's instructions and details and per the Contract Drawings. The Contractor shall furnish and install interconnecting wiring and conduits for any field mounted devices and the evaporator/condensing units and between the evaporator and condensing units. The number of control signals are per the manufacturer’s requirements. The wiring and conduit shall be installed per the electrical requirements provided in Division 26.

3.02 IDENTIFICATION

A. Each unit of equipment shall be identified with the equipment item numbers given on the Contract Drawings. A corrosion resistant tag and nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, to complete identification.

3.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions.

3.04 MANUFACTURER'S SERVICES

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall provide on-site supervision of the installation and testing of the equipment furnished under this specification and the associated appurtenances of the system.

B. The Contractor shall submit documentation from the manufacturer’s representative that certifies and agrees the installation and operational testing of all units comply with the manufacturer’s recommendations.

C. Any additional time, costs, or changes required to achieve manufacture approved successful installation and operation shall be at the expense of the Contractor.

D. Training:

1. The Contractor shall provide training for plant personnel by a certified manufacture representative. Training shall include written material and a minimum of an 8 hour day at site to train the plant personnel as to the manufacturer required equipment operation and maintenance.

3.05 GUARANTEE

A. All components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of one (1) year. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrated satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

- END OF SECTION -

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SECTION 15990

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 SCOPE

A. This section covers final testing adjusting and balancing operations after construction of the HVAC system(s).

B. The Contractor shall secure the services of an independent testing, adjusting and balancing Agency to perform complete balance, adjustment and testing of hydronic equipment and distribution systems, including pumps, air handling units, and control systems. Agency shall have on its staff at least one certified member of the National Environmental Balancing Bureau (NEBB) who has been a member in good standing for at least 3 years, and the Agency shall be NEBB certified for a period of at least three years; or Agency shall be a member of the Associated Air Balance Council (AABC) for at least 3 years.

C. Instruments used shall be accurately calibrated and maintained in good working condition. Equipment shall be as listed by ABBC or NEBB for this type work.

D. The Agency shall provide tests to demonstrate the specified capacities and operation of all equipment and materials comprising the system(s). Such tests other than as described herein, which are deemed necessary by the Engineer to indicate the fulfillment of the Contract, shall be made. The Agency shall then make available to the Engineer such instruments and technicians as are required for spot checks of the system.

E. The drawings and specifications indicate valves, controls and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. The Agency shall be consulted if there is a questionable arrangement of a control or adjustable device.

F. The Agency shall be responsible for inspecting, balancing, adjusting, testing and logging the data of the performance of the duct air distribution, controls and precision air conditioning units. The Contractor and the suppliers of the equipment installed shall all cooperate with the Agency to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiencies or non conforming operation.

1. Submit brief written report of each inspection to the Engineer, with copies to Contractor and Owner's Representative.

2. Upon completion of the installation and start-up of the mechanical equipment by the Contractor, Agency shall balance, test and adjust the system(s) components to obtain optimum conditions in each conditioned space in the building.

3. Prior to Final Application for Payment, the Contractor shall submit copies of the

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completed Testing, Adjusting and Balancing Report. The Testing, Adjusting and Balancing Report shall be complete with logs, data, and records as required herein.

4. The Report shall contain the following general data:

   a. Project No.

      1) Contract No.

      2) Project Title:

      3) Project Location:

      4) Engineer: (Name)

      5) Field Test Engineer: (Name)

      6) Testing Diagnosis and Analysis by: (Name)

      7) Agency: (Firm name, telephone number and address)

      8) Contractor: (Name and address)

      9) Inclusive dates tests were performed and date of Report

      10) Test Certification Number:

      11) Certification by Agency's Principal Engineer

   b. The Testing Adjusting and Balancing Report shall contain the following sections:

      1) Table of Contents

      2) General data and certification

      3) Brief Description of Tests and Test Procedures (including instruments used)

      4) Summary of Test Results (note deficiencies, if any, and action taken for correction)

      5) Logs, Data, and Records

1.02 REFERENCES

A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.

B. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.03 PROCEDURES

A. Operating Tests. After all mechanical systems have been completed, and prior to balance, subject each system to an operating test under design conditions to ensure proper sequence of operation in all operating modes. Make adjustments as required to ensure proper functioning of all systems.

B. Certified Data. The Contractor shall provide the Agency with the certified data on pumps, chillers and other equipment required for proper balancing of the system.

C. Adjustment. The Agency shall supervise or perform necessary adjustments to valves, pumps and other controls as required to properly balance the system.

D. Balancing. The Agency shall follow balancing and testing procedures published by the AABC, or NEBB.

E. Reports: Compile the test data on report forms as listed in the AABC "National Standards for Total System Balance".

1.04 SUBMITTALS

A. Submit Testing, Adjusting and Balancing Report as a Shop Drawing submittal under the provisions of Division 1.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 TESTING, ADJUSTING AND BALANCING

A. General Requirements

1. Do all work required for complete testing, adjusting and balancing of all systems.

2. Provide all instruments and equipment required to accomplish necessary testing, adjusting and balancing, and as required to verify performance. All instruments shall be in accurate calibration.

3. Prior to Final Application for Payment, submit a letter certifying:

a. That all balancing is complete.

b. That all controls are calibrated and functioning properly.

c. That all parts of the various systems are complete and ready to be turned over to the Owner for continuous operation.

B. Record, and Submit the following data for constant-volume supply and return air systems.

1. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

2. Measure fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

   b. Measure static pressure directly at the fan outlet or through the flexible connection.

   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

C. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

   a. Where sufficient space in sub mains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Re measure each sub main and branch duct after all have been adjusted. Continue to adjust sub mains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

F. Record, and Submit the following data for each ventilation fan and heater:

1. For each test instrument used:

   a. Instrument/Serial No.

b. Application.

c. Dates of use.

d. Calibration test date.

2. For each ventilation fan:

a. Identification Number.

b. Manufacturer.

c. Size/Model Number/Serial Number.

d. Air flow (Design\Actual).

e. Fan RPM (Design\Actual).

f. Outside air flow rate (Design\Actual).

g. Motor actual amperage and voltage at balanced flow rate.

h. Motor Nameplate full load amperage, voltage, phase, hertz, service factor, type, model number, serial number and frame number.

3. For each air device:

a. Identify location and area of each.

b. Air flow CFM rate (Design/Actual).

c. Identify and list size, type and manufacturer of diffusers, grilles, registers, and variable air box equipment.

4. For each site visit:

a. Date.

b. Time.

c. Outdoor Temperature (Wet Bulb and Dry Bulb).

d. Indoor Temperature (Wet Bulb and Dry Bulb).

G. Each control component shall be tested and verified, including but not limited to the following:

1. Sensors.

2. Interlocks.

3. Hand-off-auto switches.

4. Control sequences.

5. Safety devices.

H. After Owner has accepted the systems, make two additional inspections of the system over a one year period (one during winter operation and 1 during summer operation) to:

1. Correct any Owner observed temperature imbalances.

2. Check correct operation of equipment and verify by letter to the Engineer on each trip. List in the letter corrections made.

I. At Time of Job Completion

1. Provide such tools, equipment and personnel as required to conduct tests and demonstrate the acceptability of the various systems.

2. Have the authorized representatives of the various equipment manufacturers available if requested.

- END OF SECTION -

SECTION 16000

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental, to the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.

B. Reference Section 17000, Control and Information System Scope and General Requirements for scope of work details as they relate to the Division 17 Subcontractor.

C. The electrical scope of work for this project primarily includes, but is not limited to, the following:

1. Furnish and install low voltage motor control equipment including reduced voltage motor starters and variable frequency drives.

2. Furnish and install power panelboards, lighting panelboards, dry-type transformers, and other low voltage electrical power distribution equipment.

3. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, and other pertinent components.

4. Furnish and install all underground raceway systems including conduit, fittings, manholes, handholes and other pertinent components.

5. Furnish and install all low voltage wire and cable resulting in a complete and operable electrical system.

6. Furnish and install new lighting systems and wiring devices.

7. Other electrical work as specified herein and indicated on the Drawings.

D. All material and equipment must be the product of an established, reputable, and approved manufacturer; must be new and of first class construction; must be designed

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and guaranteed to perform the service required; and must bear the label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.

E. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.

F. Where the Contractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.

G. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.

1.02 EQUIPMENT LOCATION

A. The Drawings show the general location of feeders, transformers, outlets, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly; furnishing such fittings, junction boxes, and accessories as may be required to meet such conditions. The Contractor shall refer to the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Contractor shall verify all equipment dimensions to ensure that proposed equipment will fit properly in spaces indicated.

B. Where outlets are shown near identified equipment furnished by this or other Contractors, it is the intent of the Specifications and Drawings that the outlet be located at the equipment to be served. The Contractor shall coordinate the location of these outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings.

1.03 LOCAL CONDITIONS

A. The Contractor shall examine the site and become familiar with conditions affecting the work. The Contractor shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction. All costs, both temporary and permanent to connect all utilities, shall be included in the Bid. The Contractor shall be responsible for scheduling and coordinating with the local utility for temporary and permanent services.

B. In addition, the Contractor shall relocate all duct banks, lighting fixtures, receptacles, switches, boxes, and other electrical equipment as necessary to facilitate the Work included in this project. Costs for such work shall be included in the Bid.

C. The Contractor is responsible for coordinating all electric utility equipment installations with the serving electric utility. The Contractor shall furnish and install all electric utility equipment required by the electric utility to be installed by the Contractor whether specifically shown on the Drawings or not.

D. The Contractor shall furnish and install the following electrical utility equipment as a minimum:

1. Concrete transformer pads constructed as instructed by the electric utility.

2. Primary and or secondary ductbank and manholes

3. Metering equipment cabinets and/or bases

4. Conduit and wire required from metering cabinet to metering current transformers and potential transformers.

5. Secondary conductors

6. Secondary terminations

E. The electric utility will furnish and install the following equipment:

1. Primary conductors and terminations

F. The Contractor is responsible for ensuring all electric utility equipment and construction installed by the Contractor is furnished and installed in accordance with the electric utility's design specifications and requirements. The Contractor is fully responsible for coordinating his scope of work with the electric utility. Any additional required electric utility construction or equipment not specified herein or shown on the Drawings shall be supplied by the Contractor at no additional cost to the Owner.

G. Pennsylvania Avenue Pump Station – Site Specific Requirements

1. The existing service to the pump station is 208v, 3-phase. With the addition of 40 HP motors the service will need to be upgraded. The existing 208 volt service shall be discontinued prior to demolition of the existing pump station.

2. There is an existing utility owned Medium Voltage line passing through the existing pump station site. Contractor shall protect the existing utility lines during construction and coordinate with the utility for any required outages or temporary relocations.

3. A new 480v, 3-phase service will need to be installed prior to start-up and testing of the new pump station and related equipment.

4. Coordinate temporary service disconnections as may be required to safely execute the electrical work on this site.

5. During the testing of the new pump station, both service will be required to remain in service simultaneously.

H. Conway Avenue Pump Station – Site Specific Requirements

1. The existing service to the pump station is 208v, 3-phase. With the addition of 40 HP motors the service will need to be upgraded. The existing 208 volt service shall be discontinued prior to demolition of the existing pump station. Service shall be upgraded to 480 volt, 3-phase as indicated on the Drawings.

2. Coordinate temporary service disconnections as may be required to safely execute the electrical work on this site.

3. During the testing of the new pump station, both service will be required to remain in service simultaneously.

I. Utility Information

1. Rappahannock Electric Cooperative, Front Royal, VA

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions, Section 01300, Submittals and the requirements of the individual specification sections, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

4. Proposed Testing Methods and Reports of Certified Shop Tests.

5. Reports of Certified Field Tests.

6. Manufacturer's Representative's Certification.

B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements.

C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.

D. Some individual Division 16 specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy

of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

E. Seismic support design for all nonstructural electrical components (conduit, raceways, freestanding equipment, etc.) shall be in accordance with all applicable federal, state and local building code requirements.

1.05 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the following:

a. Insurance Rating Organization having jurisdiction

b. The serving electrical utility company

c. The currently adopted edition of the National Electrical Code (NEC)

d. The National Electric Manufacturers Association (NEMA)

e. The Institute of Electrical and Electronic Engineers (IEEE)

f. The Insulated Cable Engineers Association (ICEA)

g. The American Society of Testing Materials (ASTM)

h. The American National Standards Institute (ANSI)

i. The requirements of the Occupational Safety Hazards Act (OSHA)

j. The National Electrical Contractors Association (NECA) Standard of Installation

k. National Fire Protection Association (NFPA)

l. International Electrical Testing Association (NETA)

m. All other applicable Federal, State and local laws and/or ordinances.

2. All material and equipment shall bear the inspection labels of Underwriters Laboratories, Inc., if the material and equipment is of the class inspected by said laboratories.

B. Nonconformance

1. Any paragraph of requirements in these Specifications, or Drawings, deviating from the rules, requirements and Specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules,

requirements and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or Specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

1. Upon completion of the work, the Contractor shall obtain certificate(s) of inspection and approval from the National Board of Fire Underwriters or similar inspection organization having jurisdiction and shall deliver same to the Engineer and the Owner.

1.06 PERMITS AND INSPECTIONS

A. The Contractor shall reference the General Conditions and Section 01010, Summary of Work.

1.07 TEMPORARY LIGHTING AND POWER

A. The Contractor shall reference the General Conditions and Section 01510, Temporary Utilities.

1.08 TESTS

A. Upon completion of the installation, the Contractor shall perform tests for operation, load (Phase) balance, overloads, and short circuits. Tests shall be made with and to the satisfaction of the Owner and Engineer.

B. The Contractor shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Contractor at no cost to the Owner. The Contractor shall show by demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.

C. Refer to each individual specification section for detailed test requirements.

D. The Contractor shall complete the installation and field testing of the electrical installation at least two (2) weeks prior to the start-up and testing of all other equipment. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Contractor shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.

E. Before each test commences, the Contractor shall submit a detailed test procedure, and also provide test engineer resume, manpower and scheduling information for the approval by the Engineer. In addition, the Contractor shall furnish detailed test procedures for any of his equipment required as part of the field tests of other systems.

1.09 INFRARED INSPECTION

A. Just prior to the final acceptance of a piece of equipment, the Contractor shall perform an infrared inspection to locate and correct all heating problems associated with electrical equipment terminations.

B. The infrared inspection shall apply to all new equipment and existing equipment that is in any way modified under this Contract. All heating problems detected with new equipment furnished and installed under the Scope of this Contract shall be corrected by the Contractor. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Contractor.

C. Any issues detected with portions of existing equipment that were not modified under this Contract are not the responsibility of the Contractor. Despite the Contractor not being held responsible for these problems, the Contractor shall report them to the Owner and Engineer immediately for resolution.

D. The infrared inspection report shall include both digital and IR pictures positioned side by side. Both the digital and IR pictures shall be clear and high quality. Fuzzy, grainy, or poorly illuminated pictures are not acceptable. The IR picture shall be provided with a temperature scale beside it, and an indication of the hot spot temperature in each picture. Reports shall be furnished in a 3-ring binder, with all pages printed in full color, with equipment assemblies separated by tabs.

1.10 PROTECTIVE DEVICE SETTING AND TESTING

A. The Contractor shall provide the services of a field services organization to adjust, set, calibrate and test all protective devices in the electrical system. The organization shall be a subsidiary of or have a franchise service agreement with the electrical equipment manufacturer. The qualifications of the organization and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted.

B. All protective devices in the electrical equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.

C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.

D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers recommended test devices and procedures.

E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.

F. When completed, the Contractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.

G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

1.11 POWER SYSTEM STUDIES

A. The Contractor shall provide power systems studies performed by a registered Professional Engineer in the Commonwealth of Virginia in accordance with Section 16055 – Power System Studies.

1.12 SCHEDULES AND FACILITY OPERATIONS

A. Since the equipment testing required herein shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules must be submitted to the Engineer for review and approval one (1) month prior to any work beginning. When testing has been scheduled, the Engineer must be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of facility equipment must be coordinated with the Owner/Engineer so as not to affect proper facility operations.

B. At the end of the workday, all equipment shall be back in place and ready for immediate use should a facility emergency arise. In addition, should an emergency condition occur during testing, at the request of the Owner, the equipment shall be placed back in service immediately and turned over to Owner personnel.

C. In the event of accidental shutdown of Owner equipment, the Contractor shall notify Owner personnel immediately to allow for an orderly restart of affected equipment.

D. Maintaining the operation of these facilities during the duration of the construction period is essential and required. The Contractor shall furnish and install temporary equipment as required to maintain facility operation. Reference Section 01520 of the Specifications for construction sequencing and specific operational constraint information.

1.13 MATERIALS HANDLING

A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be temporarily connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01550, Site Access and Storage.

1.14 WARRANTIES

A. Unless otherwise specified in an individual specification section, all equipment and electrical construction materials furnished and installed under Division 16 shall be provided with a warranty in accordance with the requirements of Section 11000, Equipment General Provisions and the General Conditions.

1.15 TRAINING

A. Unless otherwise specified in an individual specification section, all training for equipment furnished and installed under Division 16 shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

PART 2 -- PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.

C. All equipment and materials shall be new, unless indicated or specified otherwise.

D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc., in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming to this requirement.

2.02 SUBSTITUTIONS

A. Unless specifically noted otherwise, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition.

2.03 CONCRETE

A. The Contractor shall furnish all concrete required for the installation of all electrical work, Concrete shall be Class A unless otherwise specified. Concrete and reinforcing steel shall meet the appropriate requirements of Division 3 of the Specifications.

B. The Contractor shall provide concrete equipment pads for all free standing electrical apparatus and equipment located on new or existing floors or slabs. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The

exact location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of these pads. Equipment pads shall be 4 inches high unless otherwise indicated on the Drawings and shall conform to standard detail for equipment pads shown on the Contract Drawings. Equipment pads shall not have more than 3" excess concrete beyond the edges of the equipment.

C. The Contractor shall provide concrete foundations for all free standing electrical apparatus and equipment located outdoors or where floors or slabs do not exist and/or are not or provided by others under this Contract. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of the foundations. Equipment foundations shall be constructed as detailed on the Drawings or if not detailed on the Drawings shall be 6 inches thick minimum reinforced with #4 bars at 12-inch centers each way placed mid-depth. Concrete shall extend 6 inches minimum beyond the extreme of the equipment base and be placed on a compacted stone bed (#57 stone or ABC) 6 inches thick minimum.

2.04 RUBBER INSULATING MATTING

A. Rubber insulating matting shall be furnished and installed on the floor and in front of each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. The mat shall be long enough to cover the full length of the equipment. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The matting shall meet OSHA requirements and the requirements of ASTM D-178 for Type 2, Class 2 insulating matting. Matting shall be 36 inches wide, minimum. However, matting width shall be no less than the NEC working clearance for the equipment with which it is associated.

B. Matting shall be provided for the following equipment:

- Panelboards
- Automatic Transfer Switches

PART 3 -- EXECUTION

3.01 CUTTING AND PATCHING

A. Coordination

1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.

B. Damage

1. The Contractor shall perform all chasing, channeling, drilling and patching necessary to the proper execution of his Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades

involved at the Contractor's expense. If, in the Engineer's judgment, the repair of damaged equipment would not be satisfactory, then the Contractor shall replace damaged equipment at his own expense.

C. Existing Equipment

1. Provide a suitable cover or plug for openings created in existing equipment as the result of work under this Contract. For example, provide round plugs in equipment enclosures where the removal of a conduit creates a hole and the enclosure. Covers and plugs shall maintain the NEMA rating of the equipment enclosure. Covers and plugs shall be watertight when installed in equipment located outdoors.

3.02 EXCAVATION AND BACKFILLING

A. The Contractor shall perform all excavation and backfill required for the installation of all electrical work. All excavation and backfilling shall be in complete accordance with the applicable requirements of Division 2.

3.03 CORROSION PROTECTION

A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

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SECTION 16055

POWER SYSTEM STUDIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide Short Circuit Studies, Equipment Evaluation Studies, Protective Device Coordination Studies, Load Flow Analyses, and Arc Flash Hazard Studies performed by a professional electrical engineer currently registered in the Commonwealth of Commonwealth of Virginia.

B. The scope of work for these studies shall include the Pennsylvania Avenue Pump Station site and for Conway Pump Station site.

C. Prior to receiving final approval of the distribution equipment shop drawings for the equipment proposed under this Contract and/or prior to release of that equipment for manufacture, the Preliminary Study Report, as specified herein, shall be submitted and approved. Contractor shall expedite the completion of the Preliminary Study Report so that final approval of proposed equipment is not delayed.

1.02 REFERENCE CODES AND STANDARDS

A. Institute of Electrical and Electronic Engineers (IEEE):

1. Standard 141, Recommended Practice for Electrical Power Distribution for Industrial Plants

2. Standard 241, Recommended Practice for Electrical Power Systems in Commercial Buildings

3. Standard 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Systems

4. Standard 399, Recommended Practice for Industrial and Commercial Power System Analysis

5. Standard 519-1992, Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

6. Standard 1584-2002/2004a, IEEE Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. Standard C37.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus

2. Standard C37.91, Guide for Protective Relay Applications to Power Transformers

3. Standard C37.95, Guide for Protective Relaying of Utility-Consumer Interconnections.

4. Standard C37.96, Guide for AC Motor Protection

5. Standard C57.12.59, Guide Dry-Type Transformer Through-Fault Current Duration

6. Standard C.57.13, Standard Requirements for Instrumentation Transformers

7. Standard C57.109, Guide for Liquid-Immersed Transformer Through Fault-Current Duration

C. National Electrical Code (NEC)

D. National Fire Protection Agency (NFPA):

1. NFPA 70E, Standard for Electrical Safety in the Workplace (2012 edition)

1.03 SUBMITTALS

A. The Contractor shall submit for review and approval, four (4) paper copies of the Preliminary Power System Studies Report, four (4) paper copies of the Pre-final Power System Studies Report, and six (6) paper copies of the Final Power System Studies Report. One (1) electronic copy of each report shall be also submitted on a CD. The electronic version of each report shall be in the PDF file format. Each section of the report shall be placed in a separate PDF file to allow fast and easy navigation between sections. Additional details regarding the report requirements are specified elsewhere herein.

B. All Reports shall bear the signature and seal of the professional electrical engineer that performed the study.

C. The Contractor shall also submit one (1) electronic copy of the system model and all required database files generated by the software analysis package used. Files shall be placed on a CD and submitted with the Preliminary, Pre-final, and Final Power System Studies Reports.

1.04 QUALIFICATIONS

A. The Power System Studies shall be performed by a professional electrical engineer registered in the Commonwealth of Virginia. The registered professional electrical engineer shall have a minimum of five (5) years of experience in performing power systems studies.

B. The resume of the registered professional electrical engineer shall be submitted for approval prior to the start of work. An experience table shall also be provided detailing the power systems studies of similar scope to this Contract that have been performed by the proposed engineer over the last two (2) years. The table shall, at a minimum, list the facility owner's name, facility contact person with phone number and email address, and overall scope of work that was provided.

PART 2 -- PRODUCTS

2.01 POWER SYSTEM STUDIES

A. General

1. The Contractor shall provide Short Circuit Studies, Equipment Evaluation Studies, Protective Device Coordination Studies, Load Flow Analyses, and Arc Flash Hazard Studies for the entire electrical system. The studies shall be performed in accordance with IEEE 399, Recommended Practice for Industrial and Commercial System Power Analysis (IEEE Brown Book).

2. The studies shall include all portions of the electrical distribution system from the serving electric utility company protective devices, the normal and standby power sources down to and including the 208 volt equipment. The studies shall include all low voltage switchgear, motor control centers (MCCs), Variable Frequency Drives (VFDs) and panelboards as shown on the Drawings. System connections and those which result in maximum fault conditions shall be adequately covered in the study.

3. The studies shall be performed with the aid of SKM Systems Analysis Power Tools for Windows (PTW) software, Version 6.5 or newer. No other software analysis packages are acceptable.

B. Data Collection for the Studies

1. The Contractor shall collect all required utility transformer and service information for use in these studies. The serving electric utility representative contact information can be found in Section 16000, Basic Electrical Requirements.

2. One (1) field visit to the project site to collect pertinent data from existing equipment by the personnel performing the studies is permitted. The visit shall span as many days as required to collect all necessary information. This visit shall occur as soon after the Contract is awarded as possible and shall be coordinated with the County. The Contractor and personnel performing these studies are responsible for collecting all required data for these studies.

C. Short Circuit Studies

1. The short circuit study shall be performed in accordance with the latest editions of IEEE Std. 399 and IEEE Std. 141.

2. The study input data shall include the serving electric utility company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.

3. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of assumed three-phase bolted short circuits at each bus, low voltage switchgear, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.

4. The short circuit study report shall include recommendations for equipment selection based on calculated short circuit values and all input and output data from the software model.

D. Equipment Evaluation Studies

1. An equipment evaluation study shall be performed to determine the adequacy of both existing and proposed circuit breakers, panelboards, motor control centers, automatic transfer switches, busses, etc. located at the plant by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. A table shall be provided in the report showing the calculated fault currents and the corresponding short circuit ratings of the existing equipment.

E. Protective Device Coordination Studies

1. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage circuit breaker trip characteristics and settings.

2. The coordination study shall include all low voltage classes of equipment from the serving electric utility company service protective devices down to and including all adjustable circuit protective devices. The phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices.

3. The time-current characteristics of the proposed protective devices shall be printed on a log-log scale. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall

be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

4. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connections, manufacturer and type, range of adjustment and recommended settings.

F. Load Flow Analyses

1. A load-flow analysis shall be performed to determine the steady-state loading profile of the plant. The analysis shall be based on both the serving electric utility as a source and the standby generator as a source. From the results of the load flow analysis, the report shall indicate areas of overloaded conductors or equipment in the power distribution system design.

2. The report shall also include a total source load summary table, as well as single line diagrams showing only the load flow data.

3. Load flow analysis results shall also be presented in a tabular format in the report.

G. Arc Flash Hazard Studies

1. An Arc Flash Hazard Study shall be performed in accordance with IEEE Std. 1584, NFPA 70E, and OSHA 29-CFR, Part 1910 Subpart S.

2. The Arc Flash Hazard Study Report shall include but not be limited to the following:

a. An executive summary outlining the electrical distribution system

b. A brief overview of what arc flash hazards are and how to avoid them.

c. Serving electric utility information received. Copies of the information received shall be included in an appendix.

d. All assumptions made to complete the report

e. Definitions of key terms used in the report

f. Any recommendations to reduce the arc flash incident energies where they are found to exceed a hazard risk category of 2.

g. A PPE table that defines the Personnel Protective Equipment (PPE) classes and clothing descriptions identified in the report and labels.

h. Arc flash hazard warning labels as specified herein.

i. An NFPA 70E energized work permit for each location where a warning label is provided.

j. Arc flash evaluation summary sheets as specified herein

k. Separate set of single line diagrams that show incident energies, hazard risk categories, and protective device settings. Only pertinent arc flash hazard data shall be displayed on these single line diagrams. Data from all other study calculations shall not be shown.

3. The following parameters shall be used in the Arc Flash Hazard Study:

a. Working distance for all equipment: 18”

b. Maximum arc duration for all equipment: 2 seconds

c. Incident energies, arc flash hazard boundaries, and hazard risk categories shall be calculated over a ±15% of calculated arcing fault current. The worst case incident energies that result shall be used in the study report.

d. The equipment that connects to both the electric utility service and the standby power is in an open-transition configuration. The power sources will be incapable of paralleling with each other.

e. The arc flash analysis shall be performed as if the facility is being supplied by either of the electric utilities <u>and</u> as if the facility is being supplied by the standby generators. The worst case values from each calculation shall be used in the study report.

4. Arc Flash Warning Labels shall be produced for each location that allows access to energized parts. Labels shall be printed in color on adhesive backed labels. Labels shall be an ANSI Z535.4 compliant (minimum size 4 in. x 6 in.) thermal transfer type label. For incident energy values of less than 40 cal/cm^2, the labels shall have an orange colored header with the word “WARNING”. For incident energy values equal to and above 40 cal/cm^2, the labels shall have a red colored header with the word “DANGER”. Each label shall include the following information:

a. Bus name

b. System operating voltage

c. Date of issue

d. Flash hazard protection boundary

e. Limited approach boundary

f. Restricted boundary

g. Prohibited boundary

h. Incident energy level

i. Required personal protective equipment class (Hazard risk category)

5. Arc Flash Evaluation Summary Sheets shall be produced. All values shown on the Summary Sheets shall be commensurate with the values shown on the single line diagrams. Summary sheets shall list the following:

a. Bus name

b. Upstream protective device name and protective device settings

c. Bus line-to-line voltage

d. Bus bolted fault

e. Protective device bolted fault current

f. Arcing fault current

g. Protective device trip / delay time

h. Breaker opening time

i. Solidly grounded column

j. Equipment type

k. Gap

l. Arc flash boundary

m. Working distance

n. Incident energy

o. Required personal protective equipment class (hazard risk category)

2.02 Study Reports

A. The results of the Power Systems Studies shall be summarized in a series of reports. A total of three (3) separate reports shall be provided as follows:

1. Preliminary Report – The Preliminary Report shall consist of all power systems studies as specified herein, with the following exceptions:

a. NFPA 70E energized work permits shall not be included

b Arc flash hazard warning labels shall be printed on plain paper for **format review purposes only**. Actual labels with calculated values shall not be included.

2. Pre-final Report – The Pre-final Report shall incorporate all comments received from the previous report review and shall include specific equipment data from the approved shop drawings of the proposed electrical equipment. The Pre-final Report shall consist of all power systems studies as specified herein, with the following exceptions:

   a. NFPA 70E energized work permits shall not be included

   b. Sample arc flash hazard warning labels shall be printed on plain paper for **calculated value review purposes**. Actual adhesive labels shall not be included.

3. Final Report – The Final Report shall consist of all power systems studies as specified herein, including final adhesive arc flash hazard warning labels. Final report shall incorporate all installed electrical equipment, including any field changes made during construction, and all comments received from the previous report review. All 'as-left' protective device settings shall be included in the report.

B. Reports shall be furnished in the quantities specified herein, neatly organized into properly identified 3" (minimum) 3-ring binders. Tabs shall clearly separate each section of the report. Each report shall begin with a table of contents. The following sections shall be included in the report as a minimum:

   1. Executive Summary

   2. Short Circuit Study

   3. Equipment Evaluations

   4. Protective Device Coordination Study

   5 Load Flow Analysis

   6. Arc Flash Study

C. All data used in the reports such as conductor sizes and lengths, motor sizes, utility contribution information, and the like shall be included in the appendices of the report.

D. All single line diagrams and time current curves shall be provided in the reports on 11x17 paper, properly folded to fit into the report binder. Use of standard 8.5x11 paper for these purposes is not permitted. Single line diagrams shall be appropriately split up between several sheets (if required) to allow the drawing scale to be adjusted in order to make text and symbols legible.

PART 3 – EXECUTION

3.01 FIELD ADJUSTMENT

A. Contractor shall adjust all relay and protective device settings according to the recommended settings table provided in the approved Pre-Final Report.

B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

3.02 ARC FLASH LABELS

A Contractor shall place approved adhesive arc flash labels on equipment after the Final Report is reviewed and approved.

3.03 TRAINING

A. The Contractor shall train the County's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

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SECTION 16111

CONDUIT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install conduits and conduit fittings to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.

B. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Section 16190, Electrical Supporting Devices, for these requirements.

C. Reference Section 16000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

A. Conduits and conduit fittings shall be designed, manufactured, and/or listed to the following standards as applicable:

1. American National Standards Institute (ANSI)

   a. ANSI B1.20.1 – Pipe Threads, General Purpose

   b. ANSI C80.1 – Electrical Rigid Steel Conduit

2. Underwriters Laboratories (UL)

   a. UL 6 - Electrical Rigid Metal Conduit-Steel

   b. UL 360 – Standard for Liquid-tight Flexible Metal Conduit

   c. UL 467 – Grounding and Bonding Equipment

   d. UL 514B – Conduit, Tubing, and Cable Fittings

   e. UL 651 – Standard for Schedule 40 and 80 Conduit and Fittings

   f. UL 1203 - Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations

3. National Electrical Manufacturer's Association (NEMA)

   a. NEMA RN 1 – PVC Externally Coated Galvanized Rigid Steel Conduit

   b. NEMA TC-2 – Electrical PVC Conduit

032717BR

c. NEMA TC-3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

B. Others

1. ACI-318 – Building Code Requirements for Structural Concrete

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets for conduits and fittings.

2. Conduit identification methods and materials.

3. Evidence of training for all personnel that will install PVC coated rigid metal conduit.

1.05 DEFINITIONS

A. Conduits are categorized by the circuit type of the wiring to be installed inside. Conduits are defined as follows:

1. Power Conduits – Conduits that carry AC or DC power wiring from a source to a load. Conduits that carry lighting and receptacle wiring.

2. Control Conduits – Conduits that carry AC or DC discrete control wiring between devices and/or equipment. Conduits that carry fiber optic cables between devices and/or equipment.

3. Instrumentation Conduits – Conduits that carry AC or DC analog signal wiring between devices and/or equipment.

B. Conduit categories are indicated on the Drawings by the leading letter of the conduit tag. Conduit tag leading letters are defined as follows:

1. P – Power Conduit

2. C – Control Conduit

3. I – Instrumentation Conduit

PART 2 – PRODUCTS

2.01 GENERAL

A. Conduit and conduit fitting products are specified in the text that follows this article. Reference Part 3 herein for the application, uses and installation requirements of these conduits and conduit fittings.

B. All metallic conduit fittings shall be UL 514B and UL 467 Listed, and constructed in accordance with ANSI FB 1. All metallic conduit fittings for use in Class I Division I hazardous areas shall be UL 1203 Listed. All non-metallic fittings shall be UL 651 Listed and constructed in accordance with NEMA TC-3.

C. Flexible conduit couplings for use in Class I Division I hazardous areas shall have threaded stainless steel end fittings and a flexible braided core. Flexible braid shall be constructed of stainless steel where available in the conduit trade size required for the application. Where stainless steel braid is not available, the braid shall be provided with a PVC coating. No other braid types or materials are acceptable.

D. Where threading is specified herein for conduit fitting connections, the fittings shall be manufactured to accept conduit that is threaded to ANSI B1.20.1 requirements.

E. Conduit expansion fittings for all conduit materials of construction shall be capable of 4 inches of movement along the axis of the conduit for trade sizes 2 inches or less. Expansion fittings shall be capable of 8 inches of movement along the axis of the conduit for trade sizes greater than 2 inches.

F. Conduit deflection fittings for all conduit materials of construction shall be provided with a flexible neoprene outer jacket that permits up to ¾ inch of expansion/contraction along the axis of the conduit as well as up to ¾ inch of parallel misalignment between the conduit axes. Outer jacket shall be secured to the conduit hubs by stainless steel clamps.

G. Conduit seals shall either be Listed and labeled for 40% fill, or conduit reducing fittings and a trade size larger conduit seal shall be provided to achieve 25% or less fill within the seal. Percentage fill calculation shall be based on the conductors to be installed. Conduit seals shall be provided with breathers and/or drains where required by the NEC.

H. Conduit insulating bushings shall be constructed of plastic and shall have internal threading.

I. Additional conduit and conduit fitting requirements are specified in the articles that follow based on the specific conduit material of construction to be used.

2.02 RIGID GALVANIZED STEEL (RGS) CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside, and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1, and shall be UL 6 Listed.

2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

B. Conduit Bodies for use with Rigid Galvanized Steel

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.

2. Conduit bodies for Class I Division I hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

3. Conduit bodies for all other areas shall be provided with covers that are affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Covers shall be provided with matching gasket.

C. Conduit Couplings, Nipples, and Unions for use with Rigid Galvanized Steel

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel. Split-type couplings that use compression to connect conduits are not acceptable.

2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

D. Conduit Expansion and Deflection Fittings for use with Rigid Galvanized Steel

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Expansion and deflection fittings shall have threaded conduit connections.

2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Seals for use with Rigid Galvanized Steel

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Galvanized Steel

1. Conduit hubs shall be constructed of stainless steel and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.

2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.

3. Conduit bonding bushings shall be constructed of zinc plated malleable iron. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.03 RIGID NONMETALLIC CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be Schedule 40 or 80 (dependent on application) polyvinyl chloride (PVC) construction, manufactured in accordance with NEMA TC-2, UL 651 Listed, and suitable for conductors with 90 degree C insulation.

B. Conduit Bodies for use with Rigid Nonmetallic Conduit

1. Conduit bodies shall be constructed of PVC. Conduit hubs shall be integral to the conduit body and shall be smooth inside to accept a glued conduit connection.

2. Conduit body shall be provided with cover that is affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Unions for use with Rigid Nonmetallic Conduit

1. Conduit couplings and unions shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

D. Conduit Expansion and Deflection Fittings for use with Rigid Nonmetallic Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

E. Conduit Termination Fittings for use with Rigid Nonmetallic Conduit

1. Conduit hubs shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. Hubs shall have external threads and an accompanying PVC locknut, and shall be watertight when assembled to an enclosure.

2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts constructed of PVC and locknuts with integral gasket or seal are not acceptable.

3. Conduit end bells shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. End bell shall have a smooth inner surface that curves outward towards the edge of the fitting.

2.04 PVC COATED RIGID GALVANIZED STEEL CONDUIT AND ASSOCIATED FITTINGS

A. General

1. Where an external coating of polyvinyl chloride (PVC) is specified for conduit and fittings, the coating shall be 40 mil (minimum) thickness. Where an internal coating of urethane is specified for conduit and fittings, the coating shall be 2 mil (minimum) thickness.

2. All conduit fittings shall have a sealing sleeve constructed of PVC which covers all connections to conduit. Sleeves shall be appropriately sized so that no conduit threads will be exposed after assembly.

B. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside, and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1, and shall be UL 6 Listed.

2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

3. Conduit shall be coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit shall be manufactured in accordance with NEMA RN-1.

C. Conduit Bodies for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit bodies shall have integral threaded conduit hubs.

2. Conduit bodies for Class I Division I hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron

alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

3. Conduit bodies for all other areas shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Covers shall be affixed in place by stainless steel screws which thread directly into the conduit body and have a plastic encapsulated head. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

D. Conduit Couplings, Nipples, and Unions for use with PVC Coated Rigid Galvanized Steel Conduit

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Split-type couplings that use compression to connect conduits are not acceptable.

2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

E. Conduit Expansion and Deflection Fittings for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Expansion and deflection fittings shall have threaded conduit connections.

2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

F. Conduit Seals for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit seals shall have threaded conduit connections.

G. Conduit Termination Fittings for Use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit hubs shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Hubs shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.

2. Conduit bonding bushings shall be constructed of zinc plated malleable iron which is coated on the exterior with a PVC jacket and coated on the interior with a layer

of urethane. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.05 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Trade size 1-1/4 inch and smaller conduits shall be provided with an integrally woven copper bonding strip.

2. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 360 Listed.

B. Conduit Termination Fittings for use with LFMC

1. Conduit termination fittings shall be constructed of either 304 stainless steel or an electro-galvanized malleable iron alloy which is coated on the exterior with a 40 mil (minimum) PVC jacket and coated on the interior with a 2 mil (minimum) layer of urethane. PVC coated fittings shall have a sealing sleeve constructed of PVC which covers the connection to conduit.

2. Termination fittings shall have a threaded end with matching locknut and sealing ring for termination to equipment, and shall have an integral external bonding lug where required for proper bonding. Termination fittings shall have a plastic insulated throat and shall be watertight when assembled to the conduit and equipment.

2.06 FLEXIBLE METAL CONDUIT (FMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Conduit shall be UL 1 Listed.

B. Conduit Termination Fittings for use with FMC

1. Conduit termination fittings shall be constructed of an electro-galvanized malleable iron alloy. Fittings shall have a threaded end with matching locknut for termination to equipment, and a compression-style connection to the associated conduit.

2.07 CONDUIT BENDS

A. Conduit bends shall be made with a bending tool appropriate for the conduit trade size. Bending radius shall be no less than the UL minimum for a factory elbow of the same trade size.

2.08 MISCELLANEOUS

A. Conduit Periphery Sealing

1. The sealing of the exterior surface of conduits to prevent water and/or air from passing around the conduit periphery from one space to another (where required) shall be through the use of one of the following:

   a. A conduit sleeve and pressure bushing sealing system. Acceptable products are FSK by OZ-GEDNEY, Link-Seal by Crouse-Hinds, or Engineer approved equal.

   b. A conduit sleeve that is two trade sizes larger than the conduit being sealed, with 2-hour fire rated UL 1479 Listed caulk filling the entire void between the conduit and sleeve. This method is only suitable for penetrations in non-fire rated walls and floors between spaces within buildings. This method shall not be used for the sealing of conduits leaving a building and/or structure.

B. Primer and Cement

1. Nonmetallic conduit shall be cleaned with primer and connected to fittings with the manufacturer's recommended cement that is labeled Low VOC.

C. Galvanizing Compounds

1. Galvanizing compounds for field application shall be the cold-applied type, containing no less than 93% pure zinc.

D. Conduit Interior Sealing

1. The sealing of the inside of conduits against water ingress shall be achieved through the use of one of the following:

   a. Two-part expanding polyurethane foam sealing compound, dispensed from a single tube which mixes the two parts as it is injected into the conduit. Expanding foam shall be compatible with the conduit material of construction as well as the outer jacket of the cables in the conduit. Acceptable products are Q-Pak 2000 by Chemque, FST by American Polywater Corporation, or Hydra-seal S-60 by Duraline.

   b. Inflatable bag that provides seal around cables and around inside diameter of conduit. Provide appropriate quantity of additional fittings for applications with three or more cables in the conduit to be sealed. Acceptable products are Rayflate by Raychem, or Engineer approved equal. This sealing method is only applicable to conduits trade size 2 inch and larger.

   c. Neoprene sealing ring provided with the required quantity and diameter of holes to accommodate the cables in each conduit. Sealing ring shall be

compressed by two stainless steel pressure plates. Acceptable products are type CSB by OZ-GEDNEY, or Engineer approved equal. This sealing method is only applicable to metallic conduits containing 4 or less cables.

2. The use of aerosol-based expanding foam sealants or any other method of sealing against water ingress not listed above is not acceptable.

E. Pull Rope

1. Pull ropes for empty and/or spare conduits shall be woven polyester, 1/2 inch wide, with a minimum tensile strength of 1250 lbs.

2. Pull ropes for the Contractors use in installing conductors shall be the size and strength required for the pull, and shall be made of a non-metallic material.

PART 3 – EXECUTION

3.01 GENERAL

A. Minimum trade size for all rigid conduits shall be 3/4 inch in exposed applications and 1 inch in embedded applications. Conduits installed within ductbanks shall be allowed to be increased in size to trade size 2 inch, at the Contractor's option, to accommodate the saddle size of the ductbank spacers. However, no combining of circuits shall be allowed in the larger conduits.

B. Minimum trade size for flexible conduits (where specifically allowed herein) shall be 1/2 inch in all applications.

C. Conduit routing and/or homeruns within structures is not shown on the Drawings. Conduits shall be installed concealed wherever practical and within the limitations specified herein. All other conduits not capable of being installed concealed shall be installed exposed.

D. Empty and/or spare conduits shall be provided with pull ropes which have no less than 12 inches of slack at each end.

E. Nonmetallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, cleaned of debris, and primer shall be applied to ready each joint for fusing. Conduits shall then be fused together with the conduit manufacturer's approved cement compound.

F. Metallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, be cleaned of all debris and be de-burred, then threaded. Conduit threading performed in the field shall be ¾ inch per foot tapered threads in accordance with ANSI B1.20.1.

G. Conduits shall be protected from moisture, corrosion, and physical damage during construction. Install dust-tight and water-tight conduit fittings on the ends of all conduits immediately after installation and do not remove until conductors are installed.

H. Conduits shall be installed to provide no less than 12 inches clearance from pipes that have the potential to impart heat upon the conduit. Such pipes include, but are not limited to, hot water pipes, steam pipes, exhaust pipes, and blower air pipes. Clearance shall be maintained whether conduit is installed in parallel or in crossing of pipes.

I. All field fabricated threads for rigid galvanized steel conduit shall be thoroughly coated with two coats of galvanizing compound, allowing at least two minutes to elapse between coats for proper drying.

J. The appropriate specialized tools shall be used for the installation of PVC coated conduit and conduit fittings. No damage to the PVC coating shall occur during installation. Conduit and conduit fittings with damaged PVC coating shall be replaced at the Contractor's cost. The use of PVC coating touch-up compounds is not permitted.

3.02 CONDUIT USES AND APPLICATIONS

A. Rigid Conduit

1. Rigid conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

RIGID CONDUIT FOR NON-HAZARDOUS AREAS		
INSTALLATION AREA DESIGNATION/ SCENARIO	**CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE**	
	Power and Control	**Instrumentation**
Exposed in indoor wet process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in outdoor areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Concealed within underground direct-bury or concrete-encased ductbanks	Schedule 40 rigid non-metallic PVC conduit	Choose an item.
Concealed within non-elevated (i.e. "slab-on-grade" construction) concrete slabs	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Emerging from concealment within or below a concrete floor and transitioning to exposed conduit	PVC coated rigid galvanized steel conduit	Same as Power and Control

2. Rigid conduit for hazardous areas shall be furnished and installed in the materials of construction as follows:

RIGID CONDUIT FOR HAZARDOUS AREAS		
	CONDUIT CATEGORY BY WIRING/CIRCUIT TYPE	
INSTALLATION AREA HAZARD/SCENARIO	Power and Control	Instrumentation
Exposed in Class I and II areas (Division I and Division II)	PVC coated rigid galvanized steel conduit	Same as Power and Control
Concealed within concrete slabs in Class I and II areas (Division I and Division II)	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs (within earth or fill material) in Class I and II areas (Division I and Division II)	Rigid galvanized steel conduit	Same as Power and Control
Concealed within concrete walls in Class I and II areas (Division I and Division II)	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs encased in at least two inches of concrete and buried 24 inches below top of slab in Class I Division I areas	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit

3. The tables for the materials of construction for rigid conduits are intended to exhaustively cover all possible scenarios and installation areas under this Contract. However, if a scenario or installation area is found that is not explicitly governed by these tables, it shall be assumed for bid purposes that the conduit material of construction is to be rigid galvanized steel. This discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution.

B. Conduit Bends

1. All conduit bends shall be the same material of construction as the rigid conduit listed in the tables above, with the following exceptions:

   a. All 90 degree bends or combinations of adjacent bends that form a 90 degree bend where concealed within concrete or below a concrete slab shall be rigid galvanized steel.

2. Field fabricated bends of metallic conduit shall be made with a bending machine and shall have no kinks. Field fabricated standard radius and long radius bends shall have minimum bending radii in accordance with the associated tables in Part 2 herein.

3. Field bending of non-metallic conduits is not acceptable, factory fabricated bends shall be used.

C. Flexible Conduit

1. Flexible conduit shall only be installed for the limited applications specified herein. Flexible conduit shall not be installed in any other application without written authorization from the Engineer. Acceptable applications are as follows:

    a. Connections to motors and engine-generator sets (and similar vibrating equipment)

    b. Connections to solenoid valves and limit switches

    c. Connections to lighting fixtures installed in suspended ceilings

    d. Connections to lighting transformers

    e. Connections to pre-fabricated equipment skids

    f. Connections to HVAC equipment

    g. Connections to instrument transmitters and elements

    h. Where specifically indicated in the Standard Details

2. Flexible conduit length shall be limited to three (3) feet, maximum. Flexible conduit shall not be installed buried or embedded within any material.

3. For Class I Division I hazardous areas, the NEC does not permit the installation of flexible conduit. In lieu of flexible conduit in these areas, flexible conduit couplings shall be installed as specified in Part 2 herein. For non-hazardous areas and Class 1, Division 2 areas where flexible connections are permitted, Liquid-tight flexible metallic conduit shall be used.

3.03 CONDUIT FITTING USES AND APPLICATIONS

A. General

1. Conduit fittings shall be furnished and installed in the materials of construction as indicated in Part 2, herein. Conduit fitting materials of construction are dependent on the material of construction used for the associated conduit.

2. Conduit fittings shall be provided in the trade size and configuration required to suit the application.

B. Conduit Bodies

1. Conduit bodies shall be installed where wire pulling points are desired or required, or where changes in conduit direction or breaking around beams is required.

2. Where conduit bodies larger than trade size 2 inches are intended to be used as a pull-through fitting during wire installation, oversized or elongated conduit bodies shall be used. Oversized or elongated conduit bodies shall not be required if the conduit body is intended to be used as a pull-out point during wire installation.

C. Conduit Nipples and Unions

1. Conduits with running threads shall not be used in place of 3-piece couplings (unions) or close nipples. After installation of a conduit fitting of any kind, there shall be no more than ¼ inch of exposed threads visible. Factory fabricated all-thread nipples may be used between adjacent enclosures, however, the same restriction applies regarding the length of exposed threads that are visible.

D. Conduit Expansion and Deflection Fittings

1. Conduit expansion fittings shall be installed where required by the NEC and where indicated on the Drawings. Expansion fittings shall also be installed for exposed straight metallic conduit runs of more than 75 feet, in both indoor and outdoor locations. Expansion fittings for runs of non-metallic conduit shall be installed in accordance with the NEC.

2. Conduit deflection fittings shall be installed where required by the NEC and where conduits are installed (exposed and concealed) across structural expansion joints.

E. Conduit Seals

1. Conduit seals shall be installed for conduits installed within or associated with hazardous areas and other areas as required by the NEC.

F. Conduit Termination Fittings

1. Where conduits terminate at enclosures with a NEMA 4, 4X, or 3R rating and the enclosure does not have integral conduit hubs, an appropriately sized watertight conduit hub shall be installed to maintain the integrity of the enclosure. The use of locknuts with integral gasket in lieu of watertight conduit hubs is not acceptable.

2. Where conduits terminate at enclosures that do not require conduit hubs, a two-locknut system shall be used to secure the conduit to the enclosure. One locknut shall be installed on the outside of the enclosure, and the other inside, drawn tight against the enclosure wall. The locknut on the interior of the enclosure shall be the type with integral bonding lug, or a conduit bonding bushing may be used in place of the locknut.

3. Conduits shall not be installed such that conduit fittings penetrate the top of any enclosure located outdoors, except in cases where specifically required by the serving electric utility. Conduits which serve outdoor equipment or an enclosure from above shall instead be routed into the side of the enclosure at the bottom. The conduit termination fitting shall be provided with a conduit drain to divert moisture from the raceway away from the enclosure.

3.04 MISCELLANEOUS

A. Conduit Periphery Sealing

1. All conduit penetrations through exterior walls shall be sealed around the periphery using the appropriate products specified in Part 2 herein to prevent air and/or water entry into the structure.

2. All conduit penetrations through interior walls and floors shall be sealed through the use of with conduit sleeves and caulk as specified in Part 2 herein. Alternatively, mortar may be used to seal around the conduit periphery.

B. Conduit Interior Sealing

1. All conduits (including spares) entering a structure below grade shall be sealed on the interior of the conduit against water ingress. Sealing shall be at an accessible location in the conduit system located within the building structure and shall be via one of the methods specified in Part 2 herein. If conduit sealing cannot be achieved at an accessible location within the building structure, sealing shall be placed in the conduits in the nearest manhole or handhole outside the structure.

3.05 CONDUIT IDENTIFICATION

A. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:

1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.

2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word “TO:” and the text in the ‘TO’ column of the conduit and wire schedule (e.g. TO: Raw Sewage Pump No. 1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word “FROM:” and the text in the ‘FROM’ column of the conduit and wire schedule (e.g. FROM: MCC-SPS). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.

3. For conduits trade sizes 3/4 inch through 1-1/2 inch, the text shall be a minimum 18 point font. For conduits trade size 2 inch and larger, the text shall be a minimum 24 point font.

4. Label height shall be 3/4 inch minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.

5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.

6. Labels shall be made of permanent vinyl with adhesive backing. Labels made of any other material are not acceptable.

3.06 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swab followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling rope.

3.07 TRAINING OF INSTALLATION PERSONNEL

A. All Contractor personnel that install PVC coated RGS conduit shall be trained by the PVC coated RGS conduit manufacturer. Training shall include proper conduit system assembly techniques, use of tools appropriate for coated conduit systems, and field bending/cutting/threading of coated conduit. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract to be considered valid. Contractor personnel not trained within this timeframe shall not be allowed to install coated conduit or shall be trained/re-trained as required prior to commencement of conduit installation.

- END OF SECTION –

SECTION 16123

LOW VOLTAGE WIRE AND CABLE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition, all low voltage wire and cable indicated on the Drawings and as specified herein and/or required for proper operation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of wire and cable systems shall be furnished and installed by the Contractor.

B. The scope of this Section does not include internal wiring factory installed by electrical equipment manufacturers.

C. Reference Section 16000 – Basic Electrical Requirements and Section 16130 – Boxes.

1.02 CODES AND STANDARDS

A. Low voltage wire, cable, and appurtenances shall be designed, manufactured, and/or listed to the following standards as applicable:

1. Underwriters Laboratories (UL)

   a. UL 13 – Standard for Power-Limited Circuit Cables

   b. UL 44 – Thermoset-Insulated Wires and Cables

   c. UL 83 – Thermoplastic-Insulated Wires and Cables

   d. UL 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

   e. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords

   f. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

   g. UL 2250 – Standard for Instrumentation Tray Cable

   h. UL 2556 – Wire and Cable Test Methods

2. American Society for Testing and Materials (ASTM)

   a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire

   b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

31294-008

c. ASTM B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

d. ASTM D69 – Standard Test Methods for Friction Tapes

e. ASTM D4388 – Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

3. Insulated Cable Engineers Association (ICEA)

a. ICEA S-58-679 – Standard for Control, Instrumentation and Thermocouple Extension Conductor Identification

b. ICEA T-29-250 – Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210,000 B.T.U./Hour

4. Institute of Electrical and Electronics Engineers (IEEE)

a. IEEE 1202 – Standard for Flame Testing of Cables

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the wire and cable manufacturer and submit the following:

1. Shop Drawings

2. Reports of Field Tests

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.

B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets for wire and cable, terminations, and pulling lubricant.

2. Cable pulling calculations (if required).

3. Wiring identification methods and materials.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar

information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 CABLE PULLING CALCULATIONS

A. Prior to the installation of the wire and cable specified herein, the Contractor shall submit cable pulling calculations for engineer review and approval when all of the following are true:

1. The amount of cable to be installed will be greater than 200 linear feet between pull points.

2. The installation will have one or more bends.

3. The wire and cable is size #1/0 AWG and larger.

B. Cable pulling calculations shall be performed by a currently registered professional engineer in the Commonwealth of Virginia and shall define pulling tension and sidewall loading (sidewall bearing pressure values).

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years. Wire and cable shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings. Only one (1) manufacturer for each wire and cable type shall be permitted.

2.02 POWER AND CONTROL WIRE AND CABLE

A. Power wire installed between the output terminals of a VFD and the respective motor shall consist of insulated copper conductors. Conductor insulation shall be rated for 90°C in both wet and dry locations, and 600V. Insulated conductors shall be UL 44 Listed as NEC Type XHHW-2.

B. Power wire for all other loads and control wire shall consist of insulated copper conductors with a nylon (or equivalent) outer jacket. Conductor insulation shall be rated 90°C for dry locations, 75°C for wet locations, and 600V. Insulated conductors shall be UL 83 Listed as NEC Type THHN/THWN.

C. Unless specified otherwise herein, conductors shall be stranded copper per ASTM B-8 and B-3, with Class B or C stranding contingent upon the size. Power conductors for lighting and receptacle branch circuits shall be solid copper per ASTM B-3.

D. Power conductor size shall be no smaller than No. 12 AWG and Control conductor size shall be no smaller than No. 14 AWG.

E. Multi-conductor cable assemblies shall include a grounding conductor and an overall PVC jacket. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Multi-conductor cable assemblies shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).

F. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, Encore Wire, or equal.

2.03 INSTRUMENTATION CABLE

A. For single-analog signal applications, instrumentation cable shall consist of a single, twisted pair or triad of individually insulated and jacketed copper conductors with an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).

B. For multiple-analog signal applications, instrumentation cable shall consist of multiple, twisted pairs or triads (i.e. groups) of individually insulated and jacketed copper conductors with individual pair/triad shields (i.e. group shields) and an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).

C. Cable and group shields shall consist of overlapped aluminum/polyester tape/foil providing 100% coverage. Instrumentation cables shall include an overall copper shield drain wire. Cables containing multiple twisted pairs or triads shall also include group shield drain wires.

D. Conductors, including drain wires, shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM B-8, with Class B stranding unless otherwise specified.

E. Instrumentation signal conductor size shall be no smaller than No. 16 AWG.

F. Instrumentation cable shall be Okoseal-N Type P-OS (for single pair or triad applications) or Okoseal-N Type SP-OS (for multiple pair or triad applications) as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or equal.

2.04 CONDUCTOR IDENTIFICATION

Conductors shall be identified using a color coding method. Color coding for individual power, control, lighting, and receptacle conductors shall be as follows:

1. 480/277V AC Power

   a. Phase A - BROWN
   b. Phase B - ORANGE
   c. Phase C - YELLOW
   d. Neutral – GREY

2. 120/208V or 120/240V AC Power

   a. Phase A - BLACK

   b. Phase B - RED

   c. Phase C - BLUE

   d. Neutral - WHITE

3. DC Power

   a. Positive Lead - RED

   b. Negative Lead - BLACK

4. DC Control

   a. All wiring - BLUE

5. 120VAC Control

   a. 120 VAC control wire shall be RED except for a wire entering a motor control center compartment, motor controller, or control panel which is an interlock. This interlock conductor shall be color coded YELLOW. For the purposes of this Section, an interlock is defined as any wiring that brings voltage into the above mentioned equipment from a source outside that equipment.

6. 24 VAC Control

   a. All wiring - ORANGE

7. Equipment Grounding Conductor

   a. All wiring - GREEN

Individual conductors No. 2 AWG and smaller shall have factory color coded insulation. It is acceptable for individual conductors larger than No.2 AWG to be provided with factory color coded insulation as well, but it is not required. Individual conductors larger than No.2 AWG that are not provided with factory color coded insulation shall be identified by the use of colored tape in accordance with the requirements listed in Part 3 herein. Insulation colors and tape colors shall be in accordance with the color coding requirements listed above.

Conductors that are part of multi-conductor cable assemblies shall have black insulation. The conductor number shall be printed on each conductor's insulation in accordance with ICEA S-58-679, Method 4. Each conductor No.2 AWG and smaller within the cable assembly shall also be identified with a heat shrink tag with color coded background. Each conductor larger than No.2 AWG within the cable assembly shall also be identified by the use of colored tape. Heat shrink tags and colored tape shall be in accordance with the requirements listed in Part 3 herein. Tape color and heat shrink tag background color shall be in accordance with the color coding requirements listed above.

2.05 CABLE PULLING LUBRICANTS

Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Yellow #77 Plus by Ideal, Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

PART 3 -- EXECUTION

3.01 WIRE AND CABLE INSTALLATION

A. General

1. Wire and Cable shall be installed as specified herein and indicated on the Drawings. Unless specifically indicated otherwise on the Drawings, wire and cable shall be installed in separate raceways according to wiring type. For example, power wiring shall not be combined with control wiring, and control wiring shall not be combined with instrumentation wiring.

2. Wire shall be furnished and installed as single conductor cables, with limited exceptions. Multi-conductor cable assemblies shall only be installed where indicated on the Drawings, required by the NEC, or after obtaining written permission from the Engineer.

3. Where instrumentation cables are installed in control panels, motor controllers, and other locations, the Contractor shall arrange wiring to provide maximum clearance between these cables and other conductors. Instrumentation cables shall not be installed in same bundle with conductors of other circuits.

4. Instrumentation cable shielding shall be continuous and shall be grounded at one point only.

B. Splices

1. Splices shall not be allowed in power or control wire and cable unless approved in writing by the Engineer. If unique field conditions exist or pulling calculations indicate that splices may be required, the Contractor shall submit a detailed request indicating why splices are required to the Engineer. The Engineer shall be under no obligation to grant such request.

2. Splicing materials shall be barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits.

3. No splicing of instrumentation cable is permitted.

C. Wire and Cable Sizes

1. The sizes of wire and cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be increased so that the voltage drop measured from source to load does not exceed 2-1/2%.

D. Additional Conductor Identification

1. In addition to the color coding identification requirements specified in Part 2 herein, individual conductors shall be provided with heat shrinkable identification tags. Identification tags for individual conductors shall have a white background where the conductor insulation is colored. Identification tags for individual conductors shall have a colored background where the conductor insulation is black. Background color shall match that of the taping provided on the individual black conductors.

2. Multi-conductor cables shall be provided with heat shrinkable identification tags in accordance with Part 2 herein.

3. All wiring shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. The Contractor shall meet with the Owner and Engineer to come to an agreement regarding a wire identification system prior to installation of any wiring. Wire numbers shall not be duplicated.

4. Wire identification shall be by means of a heat shrinkable sleeve with appropriately colored background and black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.

5. Sleeves shall be suitable for the size of wire on which they are installed. Sleeves shall not be heat-shrunk onto control cables. Tags shall remain loose on cable to promote easier identification. For all other applications, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.

6. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.

7. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.

8. Wire identification in manholes, handholes, pull boxes, and other accessible components in the raceway system where the wiring is continuous (no terminations are made) shall be accomplished by means of a tag installed around the bundled group of individual conductors or around the outer conductor jacket of a multi-conductor cable. Identification shall utilize a FROM-TO system. Each group of conductors shall consist of all of the individual conductors in a single conduit or duct. The tag shall have text that identifies the bundle in accordance with the 'FROM' and 'TO' column for that particular conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the wire bundle by the use of nylon wire ties, and shall be made of polyethylene as manufactured by Brady, Seton, Panduit, or equal.

9. Where colored tape is used to identify cables, it shall be wrapped around the cable with a 25% overlap and shall cover at least 2 inches of the cable.

E. Wiring Supplies

1. Rubber insulating tape shall be in accordance with ASTM D4388. Friction tape shall be in accordance with ASTM D69.

F. Training of Cable in Manholes, Handholes, and Vaults

1. The Contractor shall furnish all labor and material required to train cables around cable vaults, manholes, and handholes. Sufficient length of cable shall be provided in each handhole, manhole, and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any cable shall be not less than the manufacturer's recommendation. The training shall be done in such a manner as to minimize chaffing.

2. Instrumentation cable shall be racked and bundled separate from AC wiring to maintain the required separation as follows:

   a. 18 inches for 480/277VAC wiring

   b. 12 inches for 208/120VAC wiring

   c. 6 inches for 24VAC wiring

G. Conductor Terminations

1. Where wires are terminated at equipment which requires lugs, connections shall be made by solderless mechanical lug, crimp type ferrule, or irreversible compression type lugs. Reference individual equipment specification sections as applicable for additional termination requirements.

2. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make terminations impractical due to the size of the field wiring, the Contractor shall terminate field wiring in an adjacent junction box per the requirements of Section 16130 – Boxes, complete with terminal strips. Contractor shall install the smaller wiring from the device to the junction box in a conduit, using the terminal strip as the means for joining the two different wire sizes. Splicing of wires in lieu of using terminal strips is not acceptable.

3. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.

4. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for "copper-to-copper" connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or equal.

5. All spare conductors shall be terminated on terminal blocks mounted within equipment or junction boxes. Unless otherwise noted, coiling up of spare conductors within enclosure is not acceptable.

H. Pulling Temperature

1. Cable shall not be installed when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling, the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the work day for which the cable is removed from the protected storage. Any cable reels with wire remaining on them shall be returned to storage at the completion of the workday.

3.02 TESTING

A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Shop Test

a. Wires and cables shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer's standards.

2. Field Tests

a. After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be "test light" or "buzzer" style.

b. After installation, some wires and cables shall be tested for insulation levels. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:

i. For #8 AWG and larger 600V wire and cable, apply 1,000 VDC from a Megohmmeter for one (1) minute . Resistance shall be no less than 100 Megohms. Insulation testing is not required for power and control cables smaller than #8 AWG.

ii. Instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter, or approved equal. The resistance value shall be 200 Megohms or greater.

B. Wires and cables shall be tested after required terminations are made, but before being connected to any equipment.

C. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner. All conductors of a multi-phase circuit shall be replaced if one conductor fails the required

testing. If part of a multi-set (parallel conductors per phase) circuit fails testing, only the set containing failure shall be replaced.

D. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

(EXHIBIT A) TEST DATA - MEGOHMS TEST NO. ____							
Date:			Company:				
Time:			Location:				
Circuit:	Circuit Length:	Aerial:	Duct:	Buried:	No. of Conductors	Size:	AWG MCM Shield:
Insulation Material:			Insulation Thickness:		Voltage Rating:		Age:
Type: _____Pothead _____Terminal					Location: Indoors_____ Outdoors_____		
Number and Type of Joints:							
Recent Operating History:							
Manufacturer:							
State if Potheads or Terminals were grounded during test:							
List associated equipment included in test:							
Miscellaneous Information:							

(EXHIBIT A)
TEST DATA - MEGOHMS
TEST NO. ____

Part Tested:	Test Performed: _____ Hours/Days: _____ After Shutdown: _____
Grounding Time:	Dry Bulb Temperature: _____ Wet Bulb Temperature: _____
Test Voltage:	Equipment Temperature: _____ How Obtained: _____ Relative Humidity: _____ Absolute Humidity: _____ Dew Point: _____

Megohmmeter: Serial Number: _____ Range: _____
Voltage: _____ Calibration Date: _____

Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground	Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground
1/4 Minute				5 Minutes			
1/2 Minute				6 Minutes			
3/4 Minute				7 Minutes			
1 Minute				8 Minutes			
2 Minutes				9 Minutes			
3 Minutes				10 Minutes			
4 Minutes				10/1 Minute Ratio			

Remarks:

- END OF SECTION -

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The scope of work under this Section includes furnishing and installing all pull boxes, junction boxes, and outlet boxes.

B. Requirements for other boxes and enclosures are not included in this Section. Reference each specific Division 16 equipment Section for requirements related to that equipment's respective enclosure.

C. Reference Section 16000, Basic Electrical Requirements, and Section 16111, Conduit.

1.02 CODES AND STANDARDS

A. Boxes shall be designed, manufactured, and/or listed to the following standards as applicable:

1. UL 514A - Metallic Outlet Boxes

2. UL 514C - Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers

3. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations

4. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations

5. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

6. NEMA 250 – Enclosures for Electrical Equipment

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer(s) and submit the following:

1. Shop Drawings

B. Each submittal shall be identified by the applicable specification section.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible Submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets for boxes, terminal strips, and all accessories

2. Overall bill of material for all boxes included under this Contract to summarize exactly what is being submitted for review. Bill of material shall at a minimum show each box type (i.e. pull, junction, or outlet), quantity, material of construction, dimensions, and proposed installation location.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

B. As-built drawings showing dimensions, internal box layout, terminal strip information, and terminal strip identification information shall be provided for all junction boxes. As-built drawings are not required for pull boxes or outlet boxes.

1.06 IDENTIFICATION

A. Each pull and junction box shall be identified with the box name as indicated on the Contract Drawings (e.g. PPB-XXX, CJB-YYY) or as directed by the Engineer. A nameplate shall be securely affixed in a conspicuous place on each box. Nameplates shall be as specified in Section 16195, Electrical – Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 PULL AND JUNCTION BOXES

A. General

1. All pull and junction boxes shall be UL listed and labeled.

2. Pull and junction boxes shall not be provided with eccentric or concentric knockouts.

3. Pull and junction boxes mounted embedded in concrete shall be UL listed for embedment.

4. Where metallic boxes are used they shall be of all welded construction. Tack welded boxes are not acceptable.

B. Pull Boxes

1. All pull boxes shall be provided with a matching gasketed cover. For covers with dimensions of 24 inches by 24 inches or less, the cover shall be held in place by machine screws. Other screw types are not acceptable. For covers with dimensions greater than 24 inches by 24 inches, the cover shall be hinged and held in place by screw-operated clamp mechanisms. Hinge pins shall be removable. Clamp mechanism material of construction shall match that of the associated box.

2. Pull boxes shall not have any wire terminations inside, other than those for grounding/bonding. A ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the pull box (minimum of two) shall be provided as spare terminations. Boxes requiring any other wire terminations shall be furnished and installed in accordance with the requirements for junction boxes herein.

3. Pull boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC.

4. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:

   a. Power wiring

   b. AC control wiring

   c. DC control wiring

   d. Instrumentation wiring

C. Junction Boxes

1. Junction boxes used for lighting and receptacle circuits only shall be provided with a matching gasketed cover held in place by machine screws. Other screw types are not acceptable.

2. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with a hinged, gasketed cover. Hinge pins shall be removable. Cover

shall be held in place by screw-operated clamp mechanisms. Clamp mechanism material of construction shall match that of the associated box.

3. Barriers shall be provided in junction boxes to isolate conductors and terminal blocks of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:

   a. Power wiring

   b. AC control wiring

   c. DC control wiring

   d. Instrumentation wiring

4. Junction boxes used for lighting and receptacle circuits only shall be allowed to have screw-on (wire nut) type connectors for wire terminations/junctions.

5. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with terminal strips, consisting the necessary number of screw type terminals. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected, with a 10A minimum capacity. Terminal strips shall be rated for the voltage of the circuits connected. A separate ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the junction box (minimum of two) shall be provided as spare terminations. When barriers are provided within the box, separate terminal strips shall be provided in each barrier area. Terminals shall be lettered and/or numbered to conform to the wiring labeling scheme in place on the project.

6. Junction boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC. Terminal blocks (including spare terminals) shall be considered when sizing the junction box.

D. Enclosure Types and Materials

1. In non-hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	**ENCLOSURE TYPE AND MATERIAL**
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

2. In hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 4X, Type 304 Stainless Steel

3. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.

2.03 OUTLET BOXES

A. General

1. Outlet boxes shall be provided with a trim appropriate for the wiring device installed inside. Reference Section 16141, Wiring Devices, for outlet box trim requirements. An appropriate outlet box trim is required to achieve the NEMA rating of the outlet boxes as specified herein.

B. Surface Mount Outlet Boxes

1. Outlet boxes shall be the deep type, no less than 2.5 inches deep.

2. Outlet boxes shall be provided in single or multi-gang configuration as required, sized in accordance with the requirements of the NEC.

3. In non-hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
Indoor Wet Process Area	NEMA 4X, Cast Aluminum
Indoor Dry Process Area	NEMA 1, Cast Aluminum
All Outdoor Areas	NEMA 4X, Cast Aluminum

4. In hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 4X, Cast Aluminum

5. Outlet boxes shall be provided with integral threaded conduit hubs mounted external to the box. Boxes with threaded conduit hubs mounted internal to the box or as a part of the box wall are not acceptable.

C. Flush Mount Outlet Boxes

1. Outlet boxes shall be no less than 2-1/8 inches deep, and 4-11/16 inches square. Boxes shall be UL listed and labeled. Pre-punched single diameter conduit knockouts are acceptable, however, concentric and eccentric knockouts are not acceptable.

2. Outlet boxes mounted flush in CMU walls shall be made of galvanized, tack welded steel, and suitable for installation in masonry walls. Sectional type boxes are not acceptable for this application.

3. Outlet boxes mounted flush in gypsum walls shall be made of galvanized pressed steel. Tack welded boxes are not acceptable for this application. Sectional type boxes are not acceptable for this application.

4. Outlet boxes mounted cast into concrete shall be concrete tight, and shall be made of galvanized steel or PVC.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Pull and Junction Boxes

1. Pull boxes and junction boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.

2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.

3. Box penetrations for conduits shall be made with a punch tool, and penetrations shall be of the size required for the conduit entry and/or hub. Oversized penetrations in boxes are not acceptable.

4. Watertight conduit hubs shall be provided for boxes where a NEMA 4X enclosure rating is specified. Reference Section 16111, Conduit, for conduit hub requirements.

5. Pull and junction boxes may be installed flush mounted in gypsum, concrete or CMU walls where appropriate provided that covers are easily removed or opened.

6. Pull and junction boxes shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

B. Outlet Boxes

1. Outlet boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.

2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.

3. Flush mounted outlet boxes shall be arranged and located so that tile and grout lines fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.

4. Outlet boxes shall be flush mounted in finished areas and other areas where practical. Flush mounted outlet boxes shall not be installed in hazardous areas and type 1 or 2 chemical storage/transfer areas.

5. For the below-named items, mounting heights from finished floor, or finished grade to top is applicable, depending on the type of wiring device to be installed in the outlet box. Mounting heights for outlet boxes shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):

   a. Light switches and wall mounted occupancy sensors, 48 inches

   b. Receptacles in indoor dry process/non-process areas, 16 inches

   c. Receptacles in indoor wet process areas and all indoor chemical storage/transfer areas, 48 inches

   d. Receptacles in outdoor locations, 24 inches

6. Outlet boxes shall be provided in the material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

- END OF SECTION –

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SECTION 16141

WIRING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all switches, occupancy sensors, and receptacles as shown on the Drawings.

B. All switches and receptacles shall be furnished and installed in outlet boxes. Reference Section 16130, Boxes, for outlet box requirements.

C. Reference Section 16000, Basic Electrical Requirements, and Section 16123, Low Voltage Wire and Cable.

1.02 CODES AND STANDARDS

A. Wiring devices shall be designed, manufactured, and/or listed to the following standards as applicable:

1. UL 20 – General Use Snap Switches

2. UL 498 – Standard for Attachment Plugs and Receptacles

3. UL 943 – Ground Fault Circuit Interrupters

4. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

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C. Shop drawings shall include, but not be limited to:

1. Product data sheets.

1.05 SPARE PARTS

A. The Contractor shall furnish 10% (minimum of 1) spare of each receptacle, switch, and plug furnished and installed for this project.

B. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.06 IDENTIFICATION

A. Each switch and receptacle shall be identified with the equipment item number, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The Contractor shall use the products of a single manufacturer for each type of wiring device.

C. The Contractor shall use the products of a single manufacturer for all device plates. Plate variations are allowed for the following devices:

1. Where the selected plate manufacturer does not manufacture a suitable finish plate.

2. For heavy-duty receptacles rated at more than 30A.

3. Where non-standard plates are required, specified, or shown.

D. The Contractor shall furnish and install all wiring devices and device plates.

E. In non-hazardous areas, provide specification grade devices manufactured by Appleton, Crouse-Hinds, Leviton, Hubbell, Pass & Seymour, or Engineer approved equal.

F. In hazardous areas, provide devices manufactured by Appleton, Cooper Crouse-Hinds, Hubbell-Killark, or Engineer approved equal.

2.02 WIRING DEVICES

A. Wall switches for non-hazardous areas shall be rated for the current required to suit the application, but not less than 20A. Double pole, three-way, and four-way switches shall be provided where indicated on the Drawings, and as required. Switches shall be rated for 120-277VAC and shall be UL 20 Listed.

B. Convenience receptacles for non-hazardous areas shall be rated for 20A at 125VACand shall be UL 498 Listed. Receptacles shall be weather resistant where installed in wet or damp locations.

C. Special purpose receptacles (welders, lab equipment, etc.) shall be provided with the proper NEMA configuration and ampacity as indicated on the Drawings. The coordinating plug for each special purpose receptacle shall be provided with the equipment which it is serving.

D. Ground fault circuit interrupter receptacles shall be rated for 20A at 125VACand shall be UL 943 Listed. Receptacles shall be weather resistant where installed in wet or damp locations.

E. Wall switches for hazardous areas shall be the factory sealed type, UL 1203 Listed for use in the hazardous area. Wall switches shall be rated for 120-277VAC, and shall be rated for the current required to suit the application, but not less than 20A

F. Receptacles for hazardous areas shall be rated 20A at 120-240VAC. Receptacles shall be UL 1203 listed for use in the hazardous area, utilizing delayed-action construction.

G. All wiring devices shall be approved for use with stranded conductors, if stranded conductors are to be used with the device. Reference Section 16123, Low Voltage Wire and Cable for conductor requirements

2.03 DEVICE PLATES

A. Device plates for indoor flush-mounted receptacles and switches shall be made of Type 304 stainless steel, not less than 0.032 of an inch thick, with beveled edges and milled on the rear so as to lie flat against the wall. Devices plates shall be provided with a gasket.

B. Device plates for outdoor installations, indoor wet process areas, and chemical storage/transfer areas shall be Appleton Type FSK, Crouse-Hinds #DS185, or equal for wall switches. Device plates for receptacles shall be “in-use” style. “In-use” weatherproof covers shall be rugged, minimum 3 ¼” depth, die-cast aluminum as manufactured by Thomas & Betts "Red Dot," Intermatic International, Inc., or equal.

C. Device plates for indoor dry process and non-process areas with surface mounted boxes shall be Crouse-Hinds DS32, or equal for switches, and Crouse-Hinds DS23 or equal for receptacles.

2.04 PLUGS

A. The Contractor shall furnish suitable plugs with equipment furnished under the respective specification Section. Plugs shall be black rubber or plastic. For waterproof receptacles, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided with clamping nuts and stuffing gland cable outlets.

2.05 PROCESS INSTRUMENTS

A. The Contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument etc.,) to disconnect the 120VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch without overload protection as manufactured by Crouse-Hinds, Appleton equivalent, or equal. For hazardous locations, the device shall be UL 1203 Listed.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Where more than one (1) switch occurs at one (1) location, gang plates shall be used.

B. All device plates shall be set true and plumb and shall fit tightly against the finished wall surfaces and outlet boxes.

C. Wiring device box (outlet box) mounting heights shall be as specified in Section 16130, Boxes.

D. When indicated height would place any of the equipment at an unsuitable location such as at a molding or break in wall finish, the Contractor shall bring it to the attention of the Engineer for a decision.

E. Receptacles installed in toilet, locker, and bathrooms, and within 6 feet of a sink, shall be of ground fault interrupter type. Ground fault circuit interrupter receptacles shall also be furnished and installed in additional locations where indicated on the Drawings, and as required by the NEC.

F. All receptacles shall have a self-adhesive label installed on the top at the respective device plate that indicates which panel and which circuit number the receptacle is supplied from. Labels shall have a white background and black lettering in 14 point font.

G. The turn-off time delay for each occupancy sensor shall initially be set to 10 minutes. Contractor shall be responsible for the proper commissioning and testing of each occupancy sensor to ensure that it operates to the Owner and Engineer's satisfaction.

3.02 CIRCUITING

A. Convenience receptacles shall be grouped on circuits separate from the lighting circuits. A maximum of eight (8) convenience receptacles are permitted per 20A, 120V circuit, unless otherwise indicated on the Drawings.

- END OF SECTION -

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SECTION 16170

GROUNDING AND BONDING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install grounding systems complete in accordance with the minimum requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered a minimum requirement for compliance with this Specification.

B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100. Conflicts shall be promptly brought to the attention of the Engineer.

C. In addition to the NEC requirements, building structural steel columns shall be permanently and effectively grounded:

D. Reference Section 16000, Basic Electrical Requirements

1.02 CODES AND STANDARDS

A. Equipment and materials covered under this Section shall be designed, manufactured, and/or listed to the following standards as applicable:

1. UL 467 – Grounding and Bonding Equipment

2. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

3. IEEE 1100 – Recommended Practice for Power and Grounding Electronic Equipment

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Reports of certified field tests.

B. Each submittal shall be identified by the applicable specification section.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 GROUND RODS AND GRID

A. Ground rods shall be rolled to a commercially round shape from a welded copper-clad steel manufactured by the molten-welding process or by the electro-formed process (molecularly bonded). They shall have an ultimate tensile strength of 75,000 pounds per square inch (psi) and an elastic limit of 49,000 psi. The rods shall be not less than 3/4 inch in diameter by 10 feet in length; and the proportion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of 0.010 inch at any point on the rod. Ground rods shall be UL 467 listed. The ground rods shall be manufactured by Erico Products, Blackburn, or equal.

B. Except where specifically indicated otherwise, all exposed non current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductors in nonmetallic raceways and neutral conductors of wiring systems shall be grounded.

C. The ground connection shall be made at the main service equipment and shall be extended to the ground grid surrounding the structure. The ground grid shall also be connected to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flanged connection.

D. Where ground fault protection is employed, care shall be taken so that the connection of the ground and neutral does not interfere with the correct operation of the ground fault protection system.

2.03 FITTINGS

A. Grounding connections to equipment shall be bolted. Cable end connections shall be made by hydraulic crimp or exothermically welded. Split bolt type connectors are not acceptable. Fittings shall be UL 467 listed.

2.04 EQUIPMENT GROUNDING CONDUCTORS

A. An insulated equipment grounding conductor, which shall be separate from the electrical system neutral conductor, shall be furnished and installed for all circuits. Insulation shall be of the same type as the ungrounded conductors in the raceway and shall be green in color. Equipment grounding conductors shall be furnished and installed in all conduits. Use of conduits as the NEC required equipment grounding conductor is not acceptable.

2.05 EQUIPMENT GROUNDS

A. Equipment grounds shall be solid and continuous from a connection at earth to all distribution panelboards. Ground connections at panelboards, outlets, equipment, and apparatus shall be made in an approved and permanent manner.

B. For all control panels, disconnect switches, and other electrical enclosures, equipment grounds and bonding jumpers shall be terminated individually on a ground bar or mechanical lugs. No wire nuts will be permitted.

2.06 EXOTHERMIC WELDS

A. All exothermic welding shall be completed per welding kit manufacturer's instructions. Exothermic welds shall be CadWeld by Erico or ThermoWeld.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt. Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.

B. Ground Grid

1. A main ground grid shall be provided for each structure and interconnecting structure grids consisting of driven ground rods as shown on the Drawings. Ground rods shall be driven straight down into the earth, or if objects are encountered, at an angle to avoid the obstruction.

2. The ground rods shall be interconnected by the use of copper cable exothermically welded to the rods. The grounding cables shall be installed after the excavations for the building have been completed and prior to the pouring of concrete for the footings, mats, etc. Copper "pigtails" shall be connected to the ground grid and shall enter the buildings and structure from the outside and shall be connected to steel structures, and equipment as described in this Section and as required to provide a complete grounding system. The copper pigtails shall be exothermically welded to the ground grid, and connected to building reinforcement steel by hydraulic crimp.

3. Grounding conductors shall be continuous between points of connection; splices shall not be permitted.

4. Where conductors are exposed and subject to damage from personnel, traffic, etc., conductors shall be installed in metal raceway. The raceway shall be bonded to the grounding system.

5. Where subsurface conditions do not permit use of driven ground rods to obtain proper ground resistance, rods shall be installed in a trench or plate electrodes shall be provided, as applicable and necessary to obtain proper values of resistance.

6. Buried exothermic welds and ground ring shall not be backfilled until inspected by Engineer.

C. Raceways

1. Conduit which enters equipment such as switchgear, motor control centers, transformers, panelboards, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus or ground lug, where provided, and as otherwise required by the NEC.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

b. Fall of potential tests shall be performed on the ground grid per IEEE81 recommendations by a third party, independent testing firm. A fall of potential plot shall be submitted at the conclusion of testing for Engineer review. Documentation indicating the location of the rod and grounding

system as well as the resistance and soil conditions at the time the measurements were made shall be submitted. Testing shall show that the ground grid has 5 ohms resistance or less. Due to soil conditions and/or unforeseen field conditions, ground resistances greater than 5 ohms may be acceptable if specifically approved in writing by the Engineer. Ground resistance measurements shall be made in normally dry weather not less than 48 hours after rainfall and with the ground grid under test isolated from other grounds.

c. Continuity tests for the grounding electrode conductor shall be performed. Test will be accepted when a resistance of less than 1 ohm is shown for this conductor.

- END OF SECTION –

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SECTION 16190

SUPPORTING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install structural supports for mounting and installing all conduit, electrical equipment, lighting, alarm systems, instrumentation, and communications equipment furnished under this Contract.

B. Equipment shall be installed strictly in accordance with recommendations of the manufacturer and best practices of the trade resulting in a complete, operable, and safe installation. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation.

C. Reference Section 16000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

A. Equipment and materials covered under this Section shall be designed, manufactured, and/or listed to the following standards as applicable:

1. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

2. ASTM A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

3. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

4. ASTM A276 – Standard Specification for Steel Bars and Shapes

5. ASTM B783 – Standard Specification for Materials for Ferrous Powder Metallurgy Structural Parts

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop drawings

2. Structural support calculations (if required)

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B. Each submittal shall be identified by the applicable Specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 MATERIALS

A. Support channel shall be 1-5/8” by 1-5/8” minimum, with 12 gage material thickness.

B. Support channel, support channel fittings, and threaded rod shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	**MATERIAL OF CONSTRUCTION**
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Hot Dipped Galvanized Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

C. Fastening hardware (bolts, nuts, washers, and screws) shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	MATERIAL OF CONSTRUCTION
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Type 304 Stainless Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Concrete or Masonry Inserts

1. The Contractor shall be responsible for the furnishing and installation of all anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.

2. If a time delay for the arrival of any special inserts or equipment drawings, etc. occurs, the Contractor may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and, upon subsequent installation, the Contractor shall be responsible for filling in such recesses and openings. Any additional costs that may be incurred by this procedure shall be borne by the Contractor.

3. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar floor mounted equipment. The leveling channels shall be provided for embedment in the equipment housekeeping pads. Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain concrete coverage of the reinforcement bars while not causing associated equipment to exceed the maximum mounting height requirements of the NEC.

B. Support Fastening and Locations

1. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel.

2. Unless otherwise indicated on the Drawings or in the Specifications, handrails/guardrails shall not be utilized as supports for electrical equipment, devices, or appurtenances. Handrails/guardrails shall not be cut, drilled, or otherwise modified in order to accommodate electrical supports without written approval from the Engineer.

3. All holes made in reflected ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling grid bars where possible, to facilitate removal of ceiling panels.

4. Support channel shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.

5. All equipment, devices, and raceways that are installed on the dry side of a water bearing wall shall not be installed directly onto the wall. Support channel shall be used to allow ventilation air to pass behind the equipment, devices, or raceway.

6. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework.

7. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.

8. Actual designs for supporting framework should take the nature of a picture frame of support channels and bracket with a plate for mounting the components. The Contractor is responsible for the design of supporting structure; Contractor shall submit design details to the Engineer for acceptance before proceeding with the fabrication.

9. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

10. For all installations where fiberglass supporting materials are required, the Contractor shall submit structural calculations and the details of the proposed system of support. Structural calculations shall be signed and sealed by a registered professional engineer in the state in which the project is located.

11. For the following installations where conduits are provided with a support system suspended from the above or attached to a vertical structure, the Contractor shall submit structural calculations and details of the proposed system of support. Structural calculations shall be signed and sealed by a registered professional engineer in the state in which the project is located.

    a. A quantity of twelve (12) or more conduits trade size 1” and smaller are proposed for a conduit support rack.

    b. A quantity of eight (8) or more conduits trade sizes 1 ½” to 2 1/2” are proposed for a conduit support rack.

    c. A quantity of four (4) or more conduits trade sizes 3” and larger are proposed for a conduit support rack.

12. Single conduits installed exposed along walls and ceilings shall be secured to the wall or ceiling with a one-hole conduit clamp and clamp-back. Where multiple

conduits are installed exposed together, support channel and conduit clamps shall be used.

C. Equipment, boxes, and enclosures which are factory-constructed with integral mounting provisions (such as brackets, mounting feet, bolt holes, etc.) shall be installed/supported utilizing those mounting provisions. Equipment, boxes and enclosures shall not be field modified to enable mounting by any other means. Equipment, boxes, and enclosures that are field-modified by any means which compromises the UL Listing or NEMA rating of the enclosure/assembly shall be removed and replaced by the Contractor at no additional cost to the Owner

- END OF SECTION –

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SECTION 16195

ELECTRICAL - IDENTIFICATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All switchgear, switchboards, motor control centers, variable frequency drives, lighting and distribution panelboards, combination starters, control panels, pull and junction boxes, enclosures, disconnect switches, control stations, and similar equipment shall be identified in the manner described, or in an equally approved manner.

B. The types of electrical identification specified in this section include, but are not limited to, the following:

1. Operational instructions and warnings.

2. Danger signs.

3. Equipment/system identification signs.

4. Nameplates.

1.02 SIGNS

A. "DANGER-HIGH-VOLTAGE" signs shall be securely mounted on the entry doors of all electrical rooms.

1.03 LETTERING AND GRAPHICS

A. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

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1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The material covered by these Specifications is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

2.02 NAMEPLATES

A. Nameplates shall be engraved, high pressure plastic laminate, white with black lettering.

B. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or equal.

2.03 HIGH VOLTAGE SIGNS

A. Standard "DANGER" signs shall be of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where a larger size is needed for adequate identification.

2.04 CONDUIT IDENTIFICATION

A. Conduit identification shall be as specified in Section 16111, Conduit.

2.05 WIRE AND CABLE IDENTIFICATION

A. Field installed wire and cable identification shall be as specified in Section 16123,and Low Voltage Wire and Cable.

B. A plastic laminate nameplate shall be provided at each panelboard, motor control center, switchgear assembly, and switchboard assembly. This nameplate shall be used to clearly

convey the conductor identification means used at that piece of equipment (i.e. Phase A=Brown, Phase B=Orange, C = Yellow).

C. Wiring identification for factory installed wiring in equipment enclosures shall be as specified in the respective section.

2.06 BOX IDENTIFICATION

A. Pull, junction and device box identification shall be as specified in Section 16130 – Boxes.

PART 3 -- EXECUTION

3.01 NAMEPLATES

A. Nameplates shall be attached to the equipment enclosures with (2) two stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

3.03 POWER SOURCE IDENTIFICATION

A. After installation of all field equipment (i.e. valves, motors, fans, unit heaters, instruments, etc) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC number, panelboard, etc), circuit number, conduit number from schedule and voltage/phase.

B. Contractor to coordinate with the Owner regarding exact nameplate placement during construction.

C. Nameplates shall be as specified herein.

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SECTION 16440

DISCONNECT SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install separately mounted, individual disconnect switches as specified herein and indicated on the Drawings.

B. Disconnect switches for process instruments are not included in the scope of this Section and shall be as specified in Section 16141 – Wiring Devices.

1.02 CODES AND STANDARDS

A. Disconnect switches shall be designed, manufactured, and/or listed to the following standards as applicable:

1. UL 98 – Enclosed and Dead-Front Switches

2. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

3. NEMA 250 – Enclosures for Electrical Equipment

4. NEMA KS 1 – Heavy Duty Enclosed and Dead-Front Switches

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

3. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

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C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.

3. Assembled weight of each unit.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

A. The equipment shall be furnished with all spare parts as recommended by the equipment manufacturer.

B. One (1) complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.

C. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

D. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.06 IDENTIFICATION

A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the circuit number and equipment name with which it is associated. Equipment identification shall be in accordance with Section 16195, Electrical - Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Switches shall be manufactured by the Square D Company, Eaton, the General Electric Company, or Siemens Energy and Automation, Inc.

2.02 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Drawings and as required by the NEC. Handles shall be lockable.

B. Disconnect switches for non-hazardous areas shall be UL 98 Listed. Disconnect switches for hazardous areas shall be UL 1203 Listed.

C. Switches shall meet NEMA Standard KS 1 type HD requirements, be, single-throw, be externally operated, and be fused or non-fused as indicated on the Drawings. Switches shall have the number of the poles, voltage, and ampere ratings as shown on the Drawings.

D. In non-hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

E. In hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

F. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.

G. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.

H. Disconnect switches shall be furnished with a factory installed internal barrier kit that helps prevent accidental contact with live parts and provides “finger-safe” protection when the door of the enclosed switch is open.

I. Disconnect switches shall be furnished with a manufacturer-supplied ground lug kit for termination of equipment grounding conductors. Where a grounded (neutral) conductor

is shown on the Drawings in the conduits connected to the disconnect switch, a manufacturer-supplied neutral bar shall be furnished for termination of the grounded conductors. Third party ground lug and neutral lug kits not supplied by the disconnect switch manufacturer are not acceptable.

J. Fused disconnect switches shall be furnished for motor operated valve and gate actuators where shown on the Drawings. The Contractor shall coordinate the supply of these fused switches with the specific requirements of the actuator. Fuses with fast fault clearing times may be required for modulating valve actuators.

K. Disconnect switches for all motors connected to variable frequency drives (VFDs) shall be furnished with a factory installed electrical interlock kit that includes one (1) early-break auxiliary contact rated for 5A (minimum) at 120 VAC to be used to open the control circuit before the main switch blades break.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All disconnect switches shall be mounted five (5) feet above the floor or finished grade, at the equipment height where appropriate, or where shown otherwise.

B. Disconnect switches shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

- END OF SECTION -

SECTION 16470

PANELBOARDS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install panelboards of voltage and current ratings as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles and locations conforming to the panelboard schedules on the Drawings.

B. Reference Section 16000, Basic Electrical Requirements; and Section 16195, Electrical Identification.

1.02 CODES AND STANDARDS

A. Panelboards shall be designed, manufactured, and/or listed to the following standards as applicable:

1. Underwriters Laboratories

   a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations

   b. UL 67 – Standard for Panelboards

   c. UL 489 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

   d. UL 943 – Ground Fault Circuit Interrupters

   e. UL 1449 – Standard for Surge Protective Devices

2. NEMA PB1 - Panelboards

3. National Electrical Contractors Association (NECA) Standard 407 – Standard for Installing and Maintaining Panelboards

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

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2. Spare Parts List.

3. Operation and Maintenance Manuals.

4. Reports of Field Tests.

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.

3. Complete panelboard schedules indicating circuit designations as shown on the Drawings for each panelboard.

4. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g., LP-1, PP-2, etc.).

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:

1. Instruction books and/or leaflets.

2. Recommended spare parts list.

3. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process and during field installation.

1.06 SPARE PARTS

A. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer. All spaces in the panelboards shall be furnished with a spare breaker as indicated in the panelboard schedules shown on the Drawings.

B. Spare parts lists shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.07 IDENTIFICATION

A. Each panelboard shall be identified with the identification name/number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard. Nameplates shall be as specified in Section 16195, Electrical - Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 CONDUCTORS (MAIN BUS AND BRANCH CONNECTORS)

A. All main bus shall be copper sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above a maximum ambient temperature of 40 degrees C.

2.03 LIGHTING PANELBOARDS

A. General

1. Lighting panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal-overload, branch circuit breakers. Panelboards shall be of the configuration and rating as specified herein and indicated on the Drawings. Panelboards shall be UL 67 Listed and shall be constructed to NEMA PB1 standards. Panelboards shall be service entrance rated where indicated on the Drawings.

2. Lighting panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers, as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting.

3. Lighting panelboards shall be fully rated and shall have a minimum short circuit rating of 22,000 amperes symmetrical, unless otherwise indicated on the Drawings.

4. Lighting panelboards shall be Eaton Pow-R-Line Series, the Square D Company equivalent, the General Electric Company equivalent, or Siemens Energy and Automation, Inc. equivalent.

B. Enclosures

1. Enclosures shall be UL 50 listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI #61 light gray. The enclosure shall have wiring gutters on sides and shall be at least 5-3/4 inches deep.

2. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. The Contractor shall equip cabinet doors exceeding 40 inches in height with vertical bolt three point locking mechanism. All locks shall be keyed alike. The panelboard trim shall have a removable hinge assembly, in addition to the door hinge, that allows work inside the enclosure without the need to remove the trim.

3. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.

2. Solid neutral bus bars are required and neutral bus ampacity shall be the same as the main bus bars unless otherwise noted. Ratings shall be in accordance with applicable standards.

3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.

4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.

5. All bus shall be tin plated copper and shall extend the entire useable length of the panelboard, including spaces.

D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type and UL 489 Listed. All circuit breakers shall have quick-make, quick-break, toggle mechanism for manual as

well as automatic operation. Tandem or half-size circuit breakers are not acceptable.

2. Where indicated on the Drawings, or where required by Code, circuit breakers shall be equipped with integrally mounted ground fault interrupters complete with "TEST" push button and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required. Ground fault circuit interrupter style circuit breakers shall be UL 943 Listed. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.

3. Circuit breaker voltage ratings shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 240 VAC that matches the panelboard short circuit rating.

4. Main circuit breakers shall be individually mounted. Branch mounted circuit breakers are not acceptable unless specifically indicated on the panel schedules. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location.

5. Where indicated on the Drawings, branch circuit breakers shall be provided with a padlockable hasp or handle padlock attachment for padlocking in the off position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the padlock is removed. Branch circuit breakers shall be provided with a similar lock-on device where indicated on the Drawings.

E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

2.04 POWER DISTRIBUTION PANELBOARDS

A. General

1. Power distribution panelboards shall be of the configuration and rating as specified herein and as indicated on the Drawings. The panelboards shall be dead-front type with automatic trip-free, non-adjustable, thermal overload branch circuit breakers. Panelboards shall be UL 67 Listed and shall be constructed to NEMA PB1 standards. Panelboards shall be service entrance rated where indicated on the Drawings.

2. Power panelboards shall be equipped with a main breaker or main lugs complete with branch circuit breakers as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting.

3. Power distribution panelboards shall be fully rated and shall have a minimum short circuit rating of 65,000 amperes symmetrical unless otherwise indicated on the Drawings.

4. Power distribution panelboards shall be Eaton Pow-R-Line Series, the Square D Company equivalent, the General Electric Company equivalent, or Siemens Energy and Automation, Inc. equivalent.

B. Enclosures

1. Enclosures shall be UL 50 listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI #61 light gray. The enclosure shall have wiring gutters on sides and shall be at least 5-3/4 inches deep.

2. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. The Contractor shall equip cabinet doors exceeding 40 inches in height with vertical bolt three point locking mechanism. All locks shall be keyed alike. The panelboard trim shall have a removable hinge assembly, in addition to the door hinge, that allows work inside the enclosure without the need to remove the trim.

3. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1,000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement.

2. Solid neutral bus bars, where required, shall be provided. Neutral bus shall have the same ampacity as the main bus, unless otherwise indicated. Ratings shall be in accordance with applicable standards.

3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.

4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.

5. All bus shall be tin plated copper and shall extend the entire useable length of the panelboard, including spaces. Panelboards Listed and Labeled as a four-wire panel shall not be used in place of a three-wire panel where a neutral conductor does not exist in the supply conductors to that panel.

D. Circuit Breakers

1. Circuit breakers shall be bolt-on, molded-case type and UL 489 Listed. All circuit breakers shall have quick-make, quick-break, toggle mechanism for manual as well as automatic operation.

2. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked “SWD” where required by Article 440 by the NEC. Circuit breakers installed for air conditioning units shall be HACR type.

3. Circuit breaker voltage rating shall meet or exceed the panelboard voltage indicated on the Drawings. Trip elements of circuit breakers shall be 20A, unless otherwise indicated on the Drawings. Circuit breakers shall have an interrupting rating at 480 VAC that matches the panelboard short circuit rating.

4. Main circuit breakers shall be individually mounted. Branch mounted circuit breakers are not acceptable unless specifically indicated on the panel schedules. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location.

5. Where indicated on the Drawings, branch circuit breakers shall be provided with a padlockable hasp or handle padlock attachment for padlocking in the off position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the padlock is removed. Branch circuit breakers shall be provided with a similar lock-on device where indicated on the Drawings.

E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be provided in each panel. The Contractor shall maintain in each panel, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

F. The panelboards shall be furnished with integrated Type II surge protective devices (SPD). SPDs shall be provided in the location and quantity as shown on the Drawings. SPD shall be installed within the panelboard enclosure in a location that allows the required quantity and rating of branch circuit breakers to be installed. Reducing the quantity of branch circuit breakers to less than that required by the panel schedules is not acceptable.

G. The SPD shall be rated, designed, tested, listed, and labeled in accordance with UL-1449, latest edition.

H. The SPD shall be factory installed by the panelboard manufacturer using a direct bus connection. There shall be no cable connection between the bus bar and the SPD device.

I. The SPD shall have a fault current rating equal to or greater than that of the fault current rating of the panelboard. The SPD shall employ metal-oxide varistor (MOV) technology. If integral fusing is used, the fuses shall allow the maximum rated surge current to pass without fuse operation.

J. The SPD shall have a maximum continuous operating voltage (MCOV) of at least 115% of the nominal voltage of the panelboard. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

SYSTEM VOLTAGE	L-N	L-G	L-L	N-G
208Y/120	700V	700V	1200V	700V
480Y/277	1200V	1200V	1800V	1200V
480 DELTA	N/A	1200V	2000V	N/A
240 DELTA	N/A	1200V	1200V	N/A
120/240	700V	700V	1200V	700V

K. The Nominal Discharge Current (In) of the SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.

L. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated in panel schedules. Surge current rating indicated is on a per phase basis.

M. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

SYSTEM CONFIGURATION	MODES OF PROTECTION	NUMBER OF MODES
3-Phase Wye	L-N, L-G, N-G	7
3-Phase Delta	L-L, L-G	6
3-Phase Impedance Grounded	L-L, L-G	6
Single-Phase	L-N, L-G, N-G	3

N. The SPD shall be furnished with an audible alarm and silence pushbutton, integral SPD status LEDs (one per phase), and a Form C dry contact for remote indication of alarm. A surge counter shall also be provided.

O. The SPD equipment shall be SPD Series by Eaton, SurgeLogic by the Square D Company, Tranquell by the General Electric Company, Siemens Energy and Automation Inc. equivalent, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Panelboards shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer, and as required by NECA 407.

B. Panelboards shall be set true and plumb in locations as shown on the Drawings. The top of panelboard enclosure shall not exceed six (6) feet above finished floor elevation.

C. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.

D. The Contractor shall not use factory furnished knockouts with surface mounted back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush mounted back boxes with manufacturer's standard pattern of knockouts.

E. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush mounted enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.

F. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) KVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practical.

G. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Field Tests

a. Prior to termination of any conductors to the circuit breakers , all bus work and circuit breakers shall be tested from phase to phase and phase to ground with a 1000 VDC megaohmeter for 1 minute in accordance with NECA 407. Resistance values shall be recorded and shall not be less than 100 megohms.

b. Prior to terminating any wires to the circuit breakers, the resistance of the connection between the bus work and each circuit breaker shall be tested

through the use of a low-resistance ohmmeter. Record the resistance values for each circuit breaker.

- END OF SECTION -

SECTION 16476

ENCLOSED CIRCUIT BREAKERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install enclosed circuit breakers of voltage and current ratings as specified herein and indicated on the Drawings.

B. This specification is intended to apply to circuit breakers separately-mounted from other equipment in an individual enclosure. This Section does not apply to circuit breakers as part of an equipment assembly such as motor control centers, panelboards, switchboards, etc.

C. Reference Section 16000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

A. Enclosed circuit breakers shall comply with the following codes and standards:

1. UL 489 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

2. NEMA 250 – Enclosures for Electrical Equipment

3. National Electrical Code

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts List.

3. Operation and Maintenance Manuals.

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

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B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each enclosed circuit breaker.

1.05 SPARE PARTS

A. For each enclosed circuit breaker, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer.

1.06 IDENTIFICATION

A. Each enclosed circuit breaker shall be identified with the identification name and/or number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on the front of each enclosed circuit breaker. Nameplates shall be as specified in Section 16195, Electrical - Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Enclosed circuit breakers shall be manufactured by Eaton, the General Electric Company, the Square D Company, or Siemens Energy and Automation, Inc.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Circuit breakers shall be molded case type with trip and frame ratings as indicated on the Drawings. Provide electronic trip unit where indicated on the Drawings, with adjustable functions as indicated on the Drawings.

B. Circuit breakers shall have an interrupting rating of 65,000 amperes symmetrical at 480 VAC, unless otherwise indicated on the Drawings.

C. Enclosed circuit breakers in non-hazardous locations shall be UL 489 Listed. Circuit breakers in hazardous locations shall be UL 1203 Listed.

D. In non-hazardous locations, enclosed circuit breakers shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

E. In hazardous locations, enclosed circuit breakers shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

F. Enclosed circuit breakers shall be quick-make, quick-break and with an interlocked cover which cannot be opened when the breaker is in the “ON” position and capable of being locked in the “OPEN” position.

G. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the enclosure.

H. Enclosed circuit breakers shall be suitable for use as service entrance equipment where indicated on the Drawings and so labeled to suit the application.

I. Where indicated on the Drawings, enclosed circuit breakers shall be 100% rated.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The enclosed circuit breaker shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.

B. Enclosed circuit breakers shall be set true and plumb in locations as shown on the Drawings. The top of enclosure shall not exceed six (6) feet above finished floor elevation.

C. Enclosed circuit breakers shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

   a. None required

2. Field Tests

   a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

- END OF SECTION -

SECTION 16481

INDIVIDUAL MOTOR CONTROLLERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install separately mounted, individual motor controllers for 120 volt single phase, and 208 and 480 volt three phase motors as specified herein and indicated on the Drawings. Individual motor controllers specified in this Section include magnetic motor starters, manual motor starters, and reduced voltage solid state starters (RVSS).

B. Reference Section 16000, Basic Electrical Requirements; Section 16123, Low Voltage Cable; Section 16195, Electrical Identification; and Section 16902, Electric Controls and Relays.

1.02 CODES AND STANDARDS

A. Individual motor controllers shall be designed, manufactured, and/or listed to the following standards as applicable:

1. UL 508 – Standard for Industrial Control Panels

2. NEMA 250 – Enclosures for Electrical Equipment

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts.

3. Reports of Certified Shop and Field Tests.

4. Operation and Maintenance Manuals.

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

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B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Product data sheets.

3. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of individual motor controller

4. Custom wiring diagrams for each individual motor controller. Standard wiring diagrams that are not custom created by the manufacturer for the individual motor controllers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. reuse water pump) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

5. Bill of material list for each individual motor controller.

6. Nameplate schedule for each individual motor controller.

7. Manufacturer’s installation instructions.

8. Time-current curves for each type and size protective device if requested by the Engineer.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for individual motor controller. These final drawings shall

be plastic laminated and securely placed inside each individual motor controller unit door and included in the O&M manuals.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The Contractor shall furnish the following additional spare parts:

1. One (1) solid state overload relay for each type, size, and rating used.

2. One (1) motor circuit protector & motor contactor for each type, size, and rating used.

3. One (1) spare control power transformer for each type and size used.

4. Two (2) spare fuses for each size and type used.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 IDENTIFICATION

A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved with the equipment name and/or number with which it is associated. Equipment identification shall be in accordance with Section 16195, Electrical - Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be

designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 INDIVIDUAL MAGNETIC MOTOR STARTERS

A. Individual magnetic motor starters shall be combination type complete with motor circuit protectors (MCP's). Starters shall be rated 480 VAC, 3-pole, sized for the intended load unless otherwise indicated. In no case shall a starter smaller than a NEMA Size 1 be used. Each starter shall be furnished with a minimum of two spare auxiliary contacts.

B. In non-hazardous locations, motor starters shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	**ENCLOSURE TYPE AND MATERIAL**
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

C. In hazardous locations, motor starters shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	**ENCLOSURE TYPE AND MATERIAL**
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

D. Starters shall be provided with all coils and controls for 120 VAC operation, unless otherwise indicated on the Drawings.

E. The motor controller manufacturer is advised to review the total Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this Division or shown on the Drawings. Control power transformers shall be fused on both the primary and secondary sides. The minimum control power transformer VA requirements are as shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.

Size 1-150 VA
Size 2-150 VA
Size 3-200 VA
Size 4-300 VA
Size 5-500 VA

F. Each starter shall be supplied with a manual reset overload relay. Manual reset shall be accomplished by a door mounted overload reset pushbutton. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed

auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy and bi-metallic type overload relays are not acceptable.

G. Control Devices

1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16902, Electric Controls and Relays:

   a. Pilot devices (switches, indicating lights, etc.)

   b. Relays and timers

   c. Control Terminal blocks

H. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105ºC. Wire color coding shall be as specified in Section 16123, Low Voltage Cable.

I. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid state equipment (e.g. programmable logic controller) wired as part of the control circuit.

J. Individual magnetic motor starters shall be as manufactured by Eaton using NEMA rated Freedom Series starters and contactors, the General Electric Company equivalent, the Square D Company equivalent, or Siemens Energy & Automation, Inc. equivalent.

2.03 INDIVIDUAL MANUAL MOTOR STARTERS

A. Individual manual motor starters in enclosures as specified above shall be furnished and installed for outdoor and indoor exposed work. Furnish and install manual motor starters in outlet boxes with flush wall plates as required for concealed work.

B. Furnish and install manual motor starters with pilot lights and overload heater elements of correct rating based on motor nameplate data.

C. Manual motor starters shall be equipped with either a push button or toggle operator with reset device or mechanism accessible without opening the enclosure.

D. Individual manual motor starters for motors one (1) horsepower and less shall be Eaton Type MS, the General Electric Company equivalent, the Square D Company equivalent, Allen-Bradley equivalent, or Siemens Energy & Automation, Inc. equivalent.

E. Individual manual motor starters for integral horsepower motors shall be Eaton Type B100 or B101, the General Electric Company equivalents, the Square D Company equivalents, Allen-Bradley equivalent, or Siemens Energy and Automation, Inc. equivalents.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All individual motor starters shall be installed as indicated on the Drawings and as recommended by the equipment manufacturer.

B. Individual motor starters shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

   a. None required.

2. Field Tests

   a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications, latest edition.

- END OF SECTION -

SECTION 16495

VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test and place in satisfactory operating condition all variable frequency drives (VFD's) as specified herein and indicated on the Drawings.

B. Reference Section 16000, Basic Electrical Requirements, Section 16902, Electric Controls and Relays, and Section 17950, Functional Control Descriptions.

1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Certified Shop Tests and Reports

a. Submit description of proposed testing methods, procedures, and apparatus.

b. Submit notarized and certified copies of all test reports.

c. Submit factory bench-test data to indicate that the manufacturer's proposed equipment has been tested in the specified arrangement and found to achieve specified accuracy.

3. Field Tests

a. Field tests shall be performed in accordance with requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.

C. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the Contractor of responsibilities.

D. The Contractor shall successfully complete acceptance test procedures on the assembled drive system that demonstrate compliance with the requirements of this Specification. The test plan shall be submitted for acceptance at least 30 days prior to the planned test date.

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E. Drive system shall not be shipped from the manufacturing and assembly facility until the acceptance tests are completed and the acceptance tests are completed and the results approved by the test representative.

F. Tests shall be witnessed by a representative of the Engineer. Variable frequency drive manufacturer shall notify the Engineer 2 weeks in advance and shall provide testing procedures to the Engineer 4 weeks prior to actual testing. Failure of a test shall result in rejection of the equipment until performance is in compliance with these Specifications.

G. Certification on materials and records of shop tests necessary for the inspector to verify that the requirements of the Specifications are met, shall be made available to the inspector.

H. Submit signed and dated certification that all of the factory inspection and testing procedures described herein have been successfully performed by the Contractor prior to shipment.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Harmonic Study Report

3. Programming Guides/Manuals

4. Operation and Maintenance Manuals

5. Spare Parts List

6. Special Tools List

7. Shop Test Plan

8. Reports of Certified Shop and Field Tests

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.

D. Shop drawings for each VFD shall include but not be limited to:

1. Layout drawings of the variable frequency drive system that include all cabinet or enclosure dimensions, access details, and weights.

2. Layout drawings of panels or enclosures showing size, arrangement, color, and nameplates. Drawings shall include the physical arrangement of door mounted devices located on the variable frequency drive enclosure. Sufficient detail shall be provided for locating conduit stub-ups. General "catalog data sheet" layout drawings which are not specific to the systems specified herein are not acceptable.

3. Custom schematic and interconnection wiring diagrams of all electrical work, including terminal blocks and identification numbers, wire numbers and wire colors. Standard schematics and wiring diagrams that are not custom created by the manufacturer for the variable frequency drives for this project are not acceptable. These drawings shall be circuit specific for each motor-load combination (e.g. influent pumps, RAS pumps, effluent pumps, raw water pumps, etc.). Indicate all devices, regardless of their physical location, on these diagrams. Specific equipment names consistent with the Drawings shall appear on each respective diagram.

4. Complete single line diagrams indicating all devices comprising the variable frequency drive system including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system. Electrical ratings of all equipment and devices shall be clearly indicated on these single line diagrams.

5. Complete Bills of Material and catalog data sheets for all equipment and devices comprising the variable frequency drive system.

6. A complete list of recommended spare parts, including item descriptions, recommended quantities, and unit costs. The recommended list should be based on a maintenance plan where the Owner will remove and replace failed items to the lowest replaceable module/component level.

E. The shop drawing information shall be completed and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

F. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each VFD and bypass starter. These final drawings shall be plastic laminated and securely placed inside each VFD and starter door and included in the O&M manuals.

G. Product Data shall include, but not be limited to:

1. Functional diagrams that identify major system functional blocks and interfaces.

2. Special requirements or restrictions of the motor-load combination that may result from operation on the variable frequency drive system.

H. Harmonic Study and Data shall include but not be limited to:

1. Report of Harmonic Study to determine the harmonic distortion present in the voltage and current waveforms on motor terminals and in the electrical distribution system(s) caused by the variable frequency drive system as specified herein.

2. Voltage and current waveforms supplied by variable frequency drive at the motor leads.

3. Necessary descriptions regarding calculation method, assumptions, values and notations, basis for input information, manufacturer's harmonic content data, and calculation results interpretation.

I. Programming Guides and Manuals shall be submitted. If the variable frequency drive systems require computer software or configuration, provide copies of all programming guides/manuals. Flow charts and listings of software developed shall be submitted to the Engineer. Submit final flow charts and program listings no later than 6 weeks prior to factory testing of the system.

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions, Section 01300, Submittals and Section 11000, Equipment - General Provisions.

B. Operation and Maintenance Manuals shall also be provided in electronic format on CDROM.

1.06 TOOLS, SUPPLIES, AND SPARE PARTS

A. The VFD's and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.

B. The Contractor shall furnish the following spare parts <u>for each VFD</u>:

1. One set of all power and control fuses for each variable frequency drive.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.

E. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined in the General Conditions, Division 1, and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One trip of one (1) working day during installation and start-up/configuration of the equipment.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Resident representative on each day he is at the project.

1.08 IDENTIFICATION

A. Each VFD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each VFD. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.09 TRAINING

A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section.

B. Provide the services of an experienced, factory trained technician or service engineer of the variable frequency drive manufacturer at the jobsite for minimum of 1 day of Owner personnel, beginning at a date mutually agreeable to the Contractor and the Owner. The technician shall be on duty at the site for at least 8 hours per day and shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.

C. Training shall include at least two sessions for 2 designated employees for each system.

1.10 WARRANTY

A. Contractor shall warrant that the material and workmanship of all components and the operation of the variable frequency drive system and auxiliary equipment is in accordance with the latest design practices and meets the requirements of this Specification.

B. Warranty work shall include, but not be limited to, the following:

1. Replace components found to be faulty and make changes in equipment arrangement or adjustments necessary to meet the equipment or functional requirements or this Specification.

2. Warranty shall include system rewiring and substitution and rebuilt or additional equipment required during trial operation or subsequent operation of the unit during the period of this warranty.

3. Warranty shall be in effect for a period of 24 months following final acceptance of the system.

1.11 CONSTRUCTION SEQUENCING

A. The Contractor shall reference Section 01520, Maintenance of Utility Operations During Construction, of these Specifications.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

The VFDs shall be SV 9000 Series manufactured by Cutler-Hammer, Altivar 66 as manufactured by the Square D Company, the General Electric Company equivalent, Siemens Energy and Automation, Inc. equivalent, or equal.

D. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard three-wire "start-stop" and the Contractor shall furnish wiring accordingly.

E. Variable frequency drive manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all load, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.

F. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and

instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.

2.02 PRODUCT REQUIREMENTS

A. Variable speed drives shall be adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 480 volt AC NEMA Design B induction motors. Variable frequency drives for other than NEMA Design B induction motors (e.g. NEMA Design C) shall be coordinated with the requirements of that respective load.

   Drive units shall perform continuous self diagnostics as well as load and drive self check on startup.

B. All drives shall have permanently mounted programming and display modules. These modules shall provide programming access to all drive parameters, display all fault codes to assist with diagnostics and provide a display of output speed in percent or load.

C. This specification describes variable speed motor control which includes the design, fabrication, testing, installation and support requirements for variable frequency drive systems for 3-phase, squirrel cage rotor, induction motors driving pumps or other equipment. In addition to the variable frequency drive system, provide a motor controller for bypass starting during variable frequency drive downtime, where specified herein and indicated on the Drawings or described in Section 17950 Functional Control Descriptions.

D. Each variable frequency drive to be a complete alternating current electric drive system including hardware, software, technical data, and spare parts necessary to accomplish variable speed operation of an induction motor and load combination in accordance with the requirements as indicated on the Drawings and as described in these Specifications. Contractor shall refer to Section 17950 of the Specifications for a functional control description of each variable frequency drive system.

E. Variable frequency drive system manufacturer shall be responsible for the design and performance of the entire drive system and shall either manufacture all items of equipment or supply them using coordinated specifications furnished to the original equipment manufacturers to insure compatibility and performance in accordance with this Specification. Variable frequency drive manufacturer shall coordinate with suppliers of the drive motors and driven equipment. Motors shall be as specified in Section 15170 and other specific equipment Sections of the Specifications.

F. Variable frequency drive system shall be suitable for operation as part of a 480 VAC, 3-phase, 60 Hertz power distribution system. The complete variable frequency drive system shall withstand the mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.

G. The variable frequency drive system shall be suitable to operate, at times, on a limited power source engine-generator set. The system shall be provided with equipment and devices to prevent waveform distortion as specified herein.

H. Provide control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks.

I. Design each variable frequency drive motor drive speed control system so that through simple programming by either factory engineers or Owner's trained operating personnel, specific control and protection functions can be attained.

2.03 DESIGN REQUIREMENTS

A. Each variable frequency drive system shall meet the requirements of this Specification without derating any of the induction motor operating parameters including service factor and nameplate horsepower. The variable frequency drive system manufacturer shall specifically identify special requirements or restrictions of the motor-load combination that may result from operation on the variable frequency drive system.

B. The variable frequency drive shall consist of a 6 pulse diode semiconductor rectifier system, direct current link, pulse width modulated inverter and input line filtering. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the induction motor at the desired speed.

C. Variable frequency drive shall operate from fixed frequency power supply and convert this input power into variable speed induction motor shaft power as required by this Specification. Provide each variable frequency drive with a motor circuit protector as indicated on the Drawings which shall be padlockable. Include the necessary drive controllers and output contactors to accomplish the intended control of the variable frequency drive system.

D. The drive shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.

E. The overall drive system efficiency shall be a minimum of 95 percent when operating the specified motor-load combination at rated voltage, frequency, and current.

This efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$

F. Power (Load) is the total 3-phase power delivered to the motor, measured at the output terminals of the drive system, including output filters or transformers. Power (Supply) is the total electrical power delivered to the drive system, measured at the input terminals of the variable frequency drive including input filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment. Include power input required for auxiliary equipment (e.g., controls, fans, air conditioning, pumps) for complete system operating in this Power (Supply) total.

G. Variable frequency drive shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed (revolutions per minute). The variable frequency drive shall be provided with maximum and minimum frequency limits.

H. Variable frequency drive system to maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5 percent of rated frequency of 60 Hertz for a 24 hour period.

I. Variable frequency drive to have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The variable frequency drive shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.

   Variable frequency drive shall be furnished with programmable electronic overload and torque limits.

J. Drive system shall achieve a desired output frequency (setpoint) with a repeatability of 0.1 percent of rated frequency of 60 Hertz.

K. Drive system to be capable of operating the specified load continuously at any speed within the operating speed range of 10 percent to 100 percent of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.

L. Drive system controls to be microprocessor-based and have controlled linear acceleration capability to ramp up the speed, revolutions per minute, of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Provide two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. Provide controlled linear deceleration capability. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.

M. Voltage or current unbalance between phases of the variable frequency drive output voltage shall not exceed 3 percent of the instantaneous values. The variable frequency drive system shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3 percent. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.

N. Variable frequency drive system to operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10 percent for a duration of 15 cycles. Unacceptable voltage fluctuations on the supply bus shall cause under or overvoltage protection to trip and remove supply voltage from the drive system. Variable frequency drive output voltage regulation shall be plus or minus 2 percent.

The variable frequency drive system shall be furnished with line surge protection.

O. The selected drive unit shall be selected to indefinitely supply the mechanical load supplied. The Contractor is fully responsible for the review of the mechanical specifications to determine specified motor speed, horsepower and full load amperes. Where the actual full load current of a motor load is less than the presumed current value listed in Table 430.250 of the National Electrical Code, the NEC values shall supersede the nameplate current. Mechanical load information is available in the applicable mechanical specifications for each pump, drive, conveyor, blower, etc. Reference the Table of Contents.

P. The audible noise (sound pressure) level of a motor when operated from no load to full load with the variable frequency drive described herein shall not increase more than 5 decibels (dbA), at 5 feet in any direction from the motor, above its noise level when operated from a utility power source without the variable frequency drive.

Q. Variable frequency drives shall be provided with output reactors or filters to prevent elevated voltage levels at the motor terminals where indicated on the Drawings.

2.04 OPERATING CONDITIONS

A. The following operating conditions are applicable for all equipment of this Specification.

1. Humidity: 0-95 percent.

2. Ambient Temperature: Minus 20 degrees Celsius to plus 50 degrees Celsius.

3. Altitude: up to 3,300 feet

4. Power Supply: 480 volts, 3-phase, 60 Hertz.

2.05 SYSTEM FEATURES AND CHARACTERISTICS

A. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings. As a minimum, each VFD shall provide indication of the following via a panel mounted keypad:

1. Digital Speed Indicator: Revolutions per minute (input from tachometer).

2. Input Voltage

3. Output Voltage

4. Output Current

5. Output Frequency

6. Output Speed: 0-100%

7. Alarm Read-out: Display.

B. Each VFD shall provide the following automatic and manual controls. See Specification Section 16902 for panel mounted pilot devices.

1. Drive Ready Indicator: White.

2. Bypass Mode Indicator: Red.

3. Run Indicator: Red.

4. Stop Indicator: Green.

5. Running Time Meter.

6. Pump Motor Overtemperature: Amber.

7. Pump Motor Moisture: Amber.

8. VFD Fault Indicator: Amber.

9. Hand-Off-Auto Selector Switch.

10. VFD - Bypass Selector Switch (as required).

11. Local Speed Potentiometer.

12. Alarm Reset Pushbutton.

13. 24 VDC coil pilot relay for remote run command.

14. Alarm auxiliary contacts and other devices as indicated on the Drawings and specified.

15. Provision for a run permissive from other equipment when the drive is in "Auto".

C. Each VFD shall provide "potential-free" output contacts for the following conditions:

1. Drive running.

2. Drive in "Auto".

3. Drive Fault.

4. High Motor Temperature Alarm.

5. Moisture Detection/Seal Failure Alarm.

Control relays shall be as specified in Section 16902, Electrical Controls and Relays.

D. Variable frequency drive system shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback or control and remote speed indication.

E. Variable frequency drive system shall accept a 4-20 mADC input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed, revolutions per minute, equal to or less than 0.1 percent of rated speed.

F. When operating in the automatic mode, the variable frequency drive system shall shut down during a power outage. Upon restoration of normal power and after an adjustable time delay (0-2 minutes; motor has coasted to zero speed and there is no backspin), the variable frequency drive system shall automatically restart and then ramp up to speed as required by the control system. The process operator shall not be required to reset the system manually after a shutdown caused by a power outage.

G. Variable frequency drive shall be furnished with a multiple attempt restart feature.

H. Furnish a door mounted selector switch or other pilot device for those variable frequency drives where an additional speed reference signal (e.g., from a remote potentiometer, an analog output from a setpoint (PID) controller, an analog output from a programmable logic controller, or similar analog signal) is to be supplied to the variable frequency drive in addition to the door mounted manual speed control.

I. Provide a motor circuit protector and current-limiting fuses for each variable frequency drive. Provide each variable frequency drive with its respective drive controller and output contactors for each motor.

J. Include in each variable frequency drive system an automatic trip feature which will remove the drive output from the motor and allow it to decelerate safely. This automatic system shall trip and indicate the fault only upon the following conditions:

1. Output voltage unbalance (trip threshold field set).

2. Open phase.

3. Motor overload.

4. Motor stator winding fault (phase-to-ground, phase-to-phase).

5. Loss of input power to the variable frequency drive or unacceptable voltage variation.

6. High variable frequency drive equipment temperature.

7. Variable frequency drive system failure as determined by the manufacturer.

8. Component failure.

9. Overcurrent.

10. Undercurrent.

K. Provide variable frequency drive system with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the drive controller as standard, this feature shall be capable of being disabled.

L. Variable frequency drive design shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure which in turn affects motor operation and generates an alarm contact output rated for 125 VDC suitable for interfacing with the control system.

1. Diagnostics shall operate a visual alarm indicator that is visible on the variable frequency drive equipment cabinets without opening the cabinet doors.

2. Diagnostics shall provide an easily readable output that will isolate a failure.

3. Provide an event and diagnostic recorder to printout in narrative English of the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.

4. Provide a normally open dry contact for each alarm function to enable remote indication.

2.06 ENCLOSURES

A. Unless otherwise specified or indicated on the Drawings, the variable frequency drive enclosures shall be NEMA 12, force ventilated, dead-front, with front accessibility. Design enclosures for both bottom and top entry of cables. Design variable frequency drive system so that rear cabinet access is not required for operations, maintenance, and repair tasks. Other enclosure requirements are:

1. Treat metal surfaces and structural parts by phosphatizing prior to painting.

2. Apply a gun-metal gray undercoat to enclosures which is equal to zinc chromate.

3. Finish exterior of the enclosures in ANSI-61 gray enamel or furnish in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.

4. The doors shall have full length piano type hinges.

5. Brace each door to prevent sag when fully open.

The Contractor shall reference the Drawings for maximum dimensions of the VFDs.

B. Furnish each variable frequency drive system with the control switches, alarm lights and indicators as specified herein and as indicated on the Drawings. Furnish main circuit breakers with an external operating handle interlocked with the door so that the door cannot be opened unless the disconnect is in the OFF position. Power supply to the motor from both the variable frequency drive and the bypass starter shall be capable of being positively locked in the OFF position. The disconnect shall be interlocked so that equipment cannot be energized when the door is open.

C. Electrical bus, including ground bus, shall be tin-plated copper. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.

D. Equipment shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.

2.07 HARMONIC DISTORTION SUPPRESSION

A. A comprehensive pre-equipment-selection harmonic study shall be prepared by the Contractor. The results of this pre-equipment selection study shall be submitted to the Engineer as part of the submittals specified herein. Should this study indicate the need for tuned filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment, these shall be supplied at no additional cost to the Owner. Indicate the location of the harmonic suppression equipment in the submittal data. Location is subject to acceptance by the Engineer.

B. The harmonic distortion values resulting from operation of all or any variable frequency drive-driven motor-load combinations operating at full load shall be as defined in IEEE Standard 519.

1. Maximum allowable total harmonic voltage distortion (THD): 5 percent of the fundamental.

2. Maximum allowable individual frequency harmonic voltage distortion: within the limits of IEEE standard 519.

3. Maximum allowable total demand distortion (TDD): within the limits of IEEE Standard 519-1992, Table 10.3.

4. Maximum allowable individual frequency harmonic demand distortion: within the limits of IEEE Standard 519-1992, Table 10.3.

5. The harmonic distortion levels shall be specific to the "Point of Common Coupling" (PCC) as defined in IEEE Standard 519 at the demarcation point with the utility.

C. System single line diagrams and field access to the plant site will be provided to the Contractor for the purpose of providing this study. Contractor shall obtain from others other information that may be necessary to perform this study. Input data and other pertinent information used in harmonic study shall be coordinated by the Contractor with the following:

1. Input data/information/results of the short circuit fault analysis specified herein.

2. Electrical system configuration and electrical equipment shop drawing submittal data including, but not being limited to new non-linear loads, new linear loads, and new capacitors.

D. Preparation of this pre-equipment selection study does not relieve the requirement for the Contractor to perform and submit the results of a second, final comprehensive study prepared by a recognized independent authority acceptable to the Owner after equipment installation.

E. In addition, the Contractor shall field measure actual harmonic distortion and verify with tests performed by an independent authority acceptable to the Owner after satisfactory full-load operation.

F. As part of the specified harmonic studies and other work for this project, identify and correct resonance conditions in the electrical distribution system at no additional cost to the Owner. Shop drawings, data, location of the respective equipment and its connection to the electrical distribution system shall be acceptable to the Engineer.

G. Reference Section 16000, Basic Electrical Requirements for information gained from the electric utility company during the design period which could be used for the purpose of the harmonic study. Inclusion of this information, however, does not relieve the Contractor nor his suppliers of the responsibility of obtaining all the necessary information required to perform the harmonic study.

2.08 BYPASS STARTERS

A. Variable frequency drive manufacturer shall furnish and the Contractor shall install motor starters for bypass operation and associated accessories as specified herein and as indicated on the Drawings.

B. Provide bypass starters with full capacity rated contactors, each interlocked with the contactors of the variable frequency drive.

C. Where a bypass starter is to be furnished and installed in conjunction with a variable frequency drive as part of a motor control system, the variable frequency drive and the

bypass starter equipment shall be designed and manufactured to allow qualified plant personnel to safely test, maintain, and work on the VFD or the bypass starter while the motor is running. That is, plant personnel should be able to safely work on the bypass starter while the load is running via the VFD and safely work on the VFD while the load is running via the bypass starter.

2.09 MISCELLANEOUS

A. Encapsulate critical components in ceramic or metal.

B. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100 percent redundant. A new and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be acceptable.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The VFD's shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. Install VFD's to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.

C. Include in the bid an allowance for factory-trained service personnel, other than sales representatives, to supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested by the Contractor and the results of these tests have been accepted by the Engineer.

3.02 PAINTING

A. All metal surfaces of the motor control equipment shall be thoroughly cleaned and given one prime coat of zinc chromate primer. All interior surfaces shall then be given one shop furnished coat of a lacquer of the nitro-cellulose enamel variety. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be as approved by the Engineer. Color chips shall be forwarded to the Engineer for color selection and approval prior to finish painting. The interior of the VFD enclosure shall be painted white.

B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

3.03 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each VFD assembly. The mat shall be long enough to cover the full length of each VFD system.

The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION -

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SECTION 16496

AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test and place in satisfactory operation automatic transfer switches as specified herein and indicated in Drawings.

B. All devices and components of the automatic transfer switch shall be NEMA rated. IEC rated devices are unacceptable and shall be cause for rejection of the submittals/equipment.

1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

   a. Shall be made available at manufacturing facilities if requested.

2. Certified Shop Tests and Reports

   a. Automatic transfer switches shall be given routine factory tests. The factory tests shall demonstrate that the completed switches function correctly and that the required timing has been set. Certification of these settings shall be submitted to the Engineer upon request.

   b. Test procedures shall be in accordance with UL-1008. During the 3-cycle withstand tests, there shall be no contact welding or damage.

   c. The three cycle tests shall be performed without the use of current limiting fuses.

   d. Oscillograph traces across the main contacts shall verify that contact separation has not occurred and there is contact continuity across all phases after completion of the test.

   e. When conducting temperature rise tests in accordance with UL-1008, include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

   f. Manufacturer shall submit test reports upon request.

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3. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.

b. Prior to acceptance of the installation, load test the equipment with all available motor load, but do not exceed the generator's or automatic transfer switch's nameplate rating. Correct defects which become evident during this test.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts Lists

4. Special Tools List

5. Reports of certified shop tests shall be submitted which indicates a closing and withstand ampere rating as required based on short circuit study requirements. Rating shall be symmetrical, 3 cycles at 480 VAC.

6. Guarantee/Warranty Program

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor for resubmittal without review.

C. Shop drawings for each automatic transfer switch shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions and conduit entrance locations.

3. Example equipment nameplate data sheet.

4. Complete internal schematic and interconnecting wiring diagrams.

5. Nameplate schedule.

6. Manufacturer's standard installation instructions.

7. Manufacturer's warranty.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each automatic transfer switch. These final drawings shall be plastic laminated and securely placed inside each transfer switch and included in the O&M manuals.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 TOOLS, SUPPLIES AND SPARE PARTS

A. The automatic transfer switches shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment

furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined elsewhere in Division 1 and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One trip of one (1) working day during installation of the equipment for each automatic transfer switch.

2. One trip of one (1) working day after acceptance of the equipment.

3. One trip of one (1) working day during the warranty period.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Field Representative on each day he is at the project.

C. The manufacturer shall have an established network of service centers capable of servicing the specified equipment.

D. Service center personnel shall be on call 24 hours a day, 365 days a year. Personnel shall be factory-trained and certified in the maintenance and repair of the specified equipment.

E. After-warranty service contracts shall be made available to the Owner by the manufacturer, through the service centers, to provide periodic maintenance and/or repair of the specified equipment.

1.08 IDENTIFICATION

A. Each automatic transfer switch shall be identified with the identification number indicated on the Drawings (e.g. ATS-1, ATS-2, etc.). A nameplate shall be securely affixed in a conspicuous place on each switch. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.09 TRAINING

A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be in accordance with the requirements of Section 11000, Equipment-General Provisions.

B. Provide the services of an experienced, factory trained technician or service engineer of the switch manufacturer at the jobsite for minimum of one (1) day for training of Owner personnel, beginning at a date mutually agreeable to the Contractor and the Owner. The technician shall be on duty at the site for at least 8 hours per day and shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.

1.10 WARRANTY

A. The manufacturer shall warrant each automatic transfer switch for a minimum of five (5) years from date of shipment. In addition, the manufacturer shall repair or replace equipment found faulty under the terms of the warranty. The manufacturer shall submit data outlining the guarantee/warranty program.

1.11 CONSTRUCTION SEQUENCING

A. The Contractor shall reference Section 01520, Maintenance of Utility Operations During Construction, of these Specifications.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The equipment described herein, as a minimum, shall meet all of the requirements specified in this Section and shall be a product of a manufacturer who has produced automatic transfer switches for a period of at least five (5) years. The equipment shall be compatible with the loads to be served. Assembly of the switches by a fabricator is not acceptable.

C. The manufacturer of the automatic transfer switch shall verify that the switches are listed by Underwriters Laboratories, Inc., standard UL-1008, with 3-cycle withstand and close-in values as indicated on the Drawings or specified herein.

D. The automatic transfer switches shall be molded case or insulated case circuit breaker design, Type ATV (Open Transition) as manufactured by Cutler Hammer, Siemens Energy and Automation Inc. equivalent, General Electric equivalent, or equal.

2.02 AUTOMATIC TRANSFER SWITCH

A. General

1. Switches shall have ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation.

2. For three phase, four-wire systems where a neutral is required, a true four-pole switch shall be supplied with all four electrically and mechanically identical poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.

3. The transfer switch shall be housed in a NEMA 1 (gasketed) free-standing enclosure fabricated from 12-gauge steel suitable for floor mounting. The enclosure shall exceed the UL-1008 minimum wire bending space requirements. The enclosure shall be equipped with an internal, welded steel, door-mounted print pocket.

4. The transfer switch shall have both top and bottom mounted cable access.

5. The switch shall be capable of switching all classes of load and rated for continuous duty when installed in a non-ventilated enclosure.

6. The three-cycle closing and withstand current rating of the switch shall be 42,000 amperes RMS (minimum) unless otherwise indicated on the drawings. This rating shall not be restricted by the use of a specific manufacturer's circuit breaker.

7. This switch shall be complete with all accessories and listed by UL under Standard UL-1008 for use on emergency systems.

8. All bolted bus connections shall have Belleville compression type washers. Switches for four-wire systems shall be furnished with a fully rated solid neutral bus.

9. The switch shall be equipped with 90°C rated copper/aluminum solderless mechanical type lugs of the proper quantity and size to accommodate the termination of field wiring.

B. Design Requirement

1. Switches shall contain two drawout, mechanically interlocked, insulated case circuit breakers with ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation. A center-off-position shall be provided as a neutral position during switching. Minimum transfer time shall 400 milliseconds. The switches shall be service entrance rated and shall bear the service entrance label as indicated on the Drawings.

2. Switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.

3. The time delay between the opening of the closed contacts and the closing of the open contacts shall allow for voltage decay before transfer, allowing the motor and transformer loads to be re-energized after transfer with normal in-rush current.

4. Normal and standby contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts to be of silver-tungsten alloy, mechanically locked in position in both the normal and standby positions without the use of hooks, latches, or magnets. Provide separate arcing contacts, with magnetic blowouts on each pole. Interlocked molded case circuit breakers switches or contactors are not acceptable.

5. Equip the transfer switch with a permanently attached, safe, manual operator designed to prevent injury to personnel in the event the electrical operator should become energized during manual transfer. The manual operator shall provide the

same contact-to-contact transfer speed as the electrical operator to prevent a flashover from slowly switching the main contacts.

C. Sequence of Operation

1. Should the voltage on any phase of the normal source drop below 80 percent or increase to 120 percent, or frequency drops below 90 percent, or increase to 110 percent, or 20 percent voltage differential between phases occur, after a programmable time delay period of 0-9999 seconds factory set at three (3) seconds to allow for momentary dips, the engine starting contact(s) shall close to start the standby generator.

2. Transfer to the standby power source shall occur when 90 percent of rated voltage and frequency has been reached by the standby power source.

3. After restoration of normal power on all phases to a preset value of 90 percent to 110 percent of rated voltage, at least 95 percent to 105 percent of rated frequency, and voltage differential is below 20 percent between phases, an adjustable time delay period of 0-9999 seconds factory set at 300 seconds shall delay the transfer to allow stabilization of the normal source. Should the standby source fail during this time delay period, the switch shall automatically retransfer to the normal source.

4. After retransfer to the normal power source, the standby generator shall operate at no load for a programmable period of 0-9999 seconds factory set at 300 seconds. Should the normal power source fail during this time delay period, the transfer switch shall automatically return to the standby source.

D. Controls

1. The transfer switch shall be equipped with a microprocessor-based control system to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with Nicad battery back-up.

2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory, I/O, and communication circuits with a watchdog power fail circuit.

3. The controller shall use industry standard open architecture communication protocol for high speed serial communications via multidrop connection to other controllers and to a master terminal with up to 4000 ft of cable, or further with the addition of a communication repeater. The serial communication port shall be RS422/485 compatible.

4. The serial communication port shall allow interface to either the manufacturer's or the Owner's furnished remote supervisory control system.

5. The controller shall have password protection to limit access to authorized personnel.

6. The controller shall include a 20 character LCD display with a keypad, which allows access to the system.

7. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection, and phase differential monitoring on both normal and standby sources.

8. The controller shall be capable of storing the following records in memory for access either locally or remotely:

    a. Number of hours the transfer switch is in the standby position (total since record reset).

    b. Number of hours standby power source is available (total since record reset).

    c. Total transfer in either direction (total since record reset).

    d. Date, time, and description of the last four source failures.

    e. Date of the last exercise period.

    f. Date of record reset.

9. Light emitting diodes shall be mounted on the controller to indicate:

    a. Switch is in normal position

    b. Switch is in standby position.

    c. Controller is running.

10. A three-phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase-to-phase voltages simultaneously for both the normal and standby source.

11. A digital LCD frequency readout with 1% accuracy shall display frequency for both the normal and standby source.

12. An LCD readout shall display both normal source and standby source availability.

13. The microprocessor controller shall meet the following requirements:

    - Storage conditions - 25°C to 85°C

    - Operation conditions - 20°C to 70°C ambient

    - Humidity 0 to 99% relative humidity, non-condensing

- Capable of withstanding infinite power interruptions
- Surge withstand per ANSI/IEEE C-37.90A-1978

14. All control wiring shall be 18 gauge (minimum), 600 VAC, SIS switchboard type. All control wiring shall be identified at each termination (both ends) using tubular, sleeve-type wire markers.

15. The automatic transfer switch controller shall be a Model ATC-600 IQ transfer device as manufactured by Cutler-Hammer, or equal. The controller shall be programmed by the manufacturer at the factory.

E. Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

2. Programmable three phase sensing of the standby source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds.

4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds, with overrun to provide programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.

5. Time delay on transfer to standby, programmable 0-9999 seconds, factory set at 3 seconds.

6. A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.

7. A time delay bypass on retransfer to normal shall be included. Keypad initiated.

8. Contact, rated 10 A at 30VDC, to close on failure of normal source to initiate engine starting.

9. A plant exerciser shall be provided with (10) 7 day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise the standby plant programmable in one minute increments.

Also include a control switch for selection of either "no load" (switch will not transfer) or "load" (switch will transfer) during the exercise period. Keypad initiated.

10. Relay contacts which close when normal source fails wired to a terminal strip.

11. Relay contacts which open when normal source fails wired to a terminal strip.

12. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on normal and wired to a terminal strip.

13. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on standby and wired to a terminal strip.

2.03 PAINTING

A. Painting shall conform with the requirements of Section 09900. Finish coat shall be ANSI #61.

B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Each automatic transfer switch shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. The automatic transfer switch shall be provided with adequate lifting means for installation of wall or floor mounted enclosures.

C. The Contractor shall tighten all assembled bolted connections to the manufacturer's torque recommendations prior to energizing.

D. Install each switch to allow complete door swing required for component removal. This is specifically required where a switch is set next to a wall to the left of the switch enclosure.

3.02 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each automatic transfer switch. The mat shall be long enough to cover the full length of each enclosure. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION –

SECTION 16500

LIGHTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all lighting fixtures, labor, and material, in accordance with the preceding Specifications, the requirements of this Section, and as shown on the Drawings.

B. Lighting shall be in accordance with the latest requirements of the Illuminating Engineering Society, and all lighting fixtures shall have the Underwriters Laboratories, Inc. label of approval.

C. All wiring shall be placed in conduit and shall comply with the Specifications for conduit, outlet boxes, pull and junction boxes, wires and cables, grounding, and other Sections as set forth in these Specifications and as noted herein.

D. Reference Section 16000, Basic Electrical Requirements, and Section 16170, Grounding and Bonding.

1.02 CODES AND STANDARDS

A. The equipment specified herein shall comply with the following codes and standards, where applicable.

1. Underwriter's Laboratories, Inc. (UL):

   a. UL 924 – Emergency Lighting and Power Equipment

   b. UL 1598 – Luminaires

2. American National Standards Institute (ANSI):

   a. ANSI C62.41 – Guide for Surge Voltages in Low-Voltage AC Power Circuits

3. National Electrical Code (NEC), latest edition.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts Lists

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor for resubmittal without review.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Catalog cuts for each fixture type showing performance and construction details of standard fixtures, and complete working drawings showing all proposed construction details of special or modified standard fixtures.

3. Photometric curves.

4. LED data.

5. LED Driver information

6. Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.

7. Manufacturer’s warranty information

8. Custom wiring diagrams for each individual lighting contactor. Standard wiring diagrams that are not custom created by the manufacturer for the individual lighting contactors for this project are not acceptable. One wiring diagram which is typical for all lighting contactors is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate <u>all</u> devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

D. Shop drawings shall be submitted to the Engineer for review and acceptance for all fixtures before fixtures and poles are manufactured. Substitutions will be permitted only if acceptable to the Engineer.

E. Manufacturer's catalog number and description in the fixture schedule on the Contract Documents establishes a level of quality, style, finish, etc. The use of a catalog number

describing the various types of fixtures shall be used as a guide only, and does not exclude all the required accessories or hardware that may be required for a complete installation.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit Operation and Maintenance Manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The following minimum spare parts shall be furnished:

1. A minimum of one (1) LED driver for every ten (10) drivers (of the same type) installed.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 LIGHTING CONTROLS

A. The lighting systems shall be controlled as specified herein and indicated on the Drawings.

1.08 WARRANTY

A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of delivery of fixtures to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, shipping costs, expendables used during the course of repair, or complete replacement of the failed lighting unit.

B. Warranty for LED fixtures shall be provided for the entire fixture and shall include all parts and accessories. Warranty for non-LED fixtures shall be provided for the entire fixture and shall include all parts and accessories except the replaceable bulb. Submittals received without written warranties as specified shall be rejected in their entirety.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 FIXTURES

A. Each fixture shall bear the Underwriters Laboratories, Inc. label. All lighting fixtures shall be furnished complete with lamps of the size and type as indicated on the Drawings and all fittings and hardware necessary for a complete installation. Lighting fixtures shall have all parts and fittings necessary to completely and properly install the fixtures.

B. Fixture leads shall be as required by NEC and shall be grounded by the equipment grounding conductor in the conduit.

C. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.

D. Emergency fixtures shall be UL 924 listed and have a minimum 90 minutes battery back-up.

E. Fixtures for use in hazardous locations shall be UL 844 Listed.

F. Fixtures specified to be damp or wet locations rated shall be UL 1598 listed.

G. Fluorescent fixtures shall be complete with housing, louvers (if required), and accessories of the types and quantities specified herein and indicated on the Drawings.

H. Fixtures shall be as specified as shown on the Fixture Schedule provided in the Drawings.

2.03 LED DRIVERS

A. Drivers shall have a voltage range of (120-277) +/- 10% at a frequency 60Hz.

B. All drivers shall be designed to a power factor >90% with a total harmonic distortion THD <20% at full load.

C. Case temperature shall be rated for -40°C through +80°C.

D. Drivers shall have overheat protection, self-limited short circuit protection and overload protected.

E. Drivers shall be furnished with a fused primary.

F. Drivers shall have an output current ripple <30%

G. Drivers shall be manufactured by Advance, Universal or equal.

H. Drivers shall be UL Listed for damp location, UL1012, UL935, ROHS.

I. Drivers shall meet FCC 47 Sub Part 15.

J. All drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

2.04 LEDs

A. Luminaires provided with LED technology shall utilize high brightness LEDs with a group binning code of P and/or Q.

B. Color Temperature: as specified in fixture schedule.

C. Junction point shall be designed and manufactured to allow adequate heat dissipation.

D. LEDs shall be rated for 50,000 hours of life, minimum (based on IESNA L70).

2.05 POLES

A. Poles shall be designed to withstand calculated wind force based on 110 MPH (3-second gust) wind velocity in accordance with the provisions of the International Building Code without structural damage.

B. Pole mounted fixtures shall be mounted on poles as designated in the fixture schedule or as indicated on the Drawings. Poles shall have adequate handholes and weatherproof receptacles where indicated. All anchor bolts and nuts shall be stainless steel.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Lighting fixtures shall be located symmetrically with building lines as shown on the Drawings. The Contractor shall furnish and install the lighting fixtures to allow "convenient" access for maintenance such as cleaning, relamping, and other activities. The fixtures shall be installed to be accessed by a 12 ft. (max.) ladder. Where fixtures are shown in locations on the Drawings where maintenance would be difficult, the Contractor shall notify the Engineer for direction.

B. The Contractor shall provide and install all inserts, conduit, structural supports as required, lamps, ballasts, poles, wiring, and any other items required for a complete system. Contractor shall properly adjust and test, to the satisfaction of the Engineer, the entire lighting system. The Contractor shall provide pigtails and flexible conduit connected to an outlet box where necessary or required resulting in a neat and complete installation.

C. The Contractor shall protect all fixtures at all times from damage, dirt, dust, and the like. Before final acceptance, all fixtures and devices shall be cleaned of all dust, dirt or other

material, be fully re-lamped (except LED fixtures) and in operating condition to the satisfaction of the Engineer.

D. The Contractor shall furnish and install all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hanger permitting normal fixture motion and self-alignment. Fixture pendants shall be Appleton Type UNJ ball type flexible hanger at the fixture and supports from an Appleton JBLX junction box with JBLX hub cover, or equal. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be one-piece, with matching canopies and fittings.

E. Fixtures located on the exterior of the building shall be provided with neoprene gasket and non-ferrous metal screws finished to match the fixtures.

F. The finish or exposed metal parts of lighting fixtures and finish trims of all recessed lighting fixtures shall be as directed by the Engineer.

G. The Contractor shall furnish and install recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.

H. The Contractor shall furnish and install all boxes for lighting fixtures such that the box is not the sole support of the fixture. The boxes shall be offset to allow maintenance such that access to wiring within the box can be attained without having to consider supporting (holding) the fixture.

I. All lighting units, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.

J. The Contractor shall install fixtures at mounting heights indicated on the Drawings or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer.

K. The Contractor shall support each fixture securely. Each fixture shall be secured to the building structure where indicated. The Contractor shall not secure fixtures to the work of other trades, unless specified or noted otherwise, and shall not support fixtures from plaster. The Contractor shall furnish and install all steel members and supports as required to fasten and suspend fixtures from the structure.

L. In all mechanical equipment areas, the Contractor shall install lighting fixtures on the ceiling after all piping and equipment therein has been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.

M. Upon completion of work, and after the building area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, and lamps.

N. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures and/or lamps, as directed.

O. Relamping access of fixtures including LED fixtures shall require no special tools. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of special tools. No fixture part that may be removed, for maintenance, shall be held in place by metal tabs that must be bent to remove said part.

P. The Contractor shall furnish and install time switches and photocells as specified herein or indicated on the Drawings. Time switches shall be provided with a manual bypass switch controlling the lights locally and remotely. Time switches shall control contactors, relays, or direct controlling of one, two, or three lighting circuits, as indicated. The Contractor shall furnish and install photocells as specified herein or indicated on the Drawings for automatic "ON/OFF" switching of outdoor lighting.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Certified Shop Tests

a. The lighting fixtures shall be given routine factory tests in accordance with the requirement of ANSI, NEMA and Underwriters Laboratories standards.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

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SECTION 16620

PACKAGED ENGINE GENERATOR SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install a standby power engine generator set complete with base-mounted fuel storage tank, fuel pumps, leak detection systems, piping, exhaust silencer, batteries, charger, enclosure, and devices for automatic and manual control.

B. It is the intent under this Contract to require an installation complete in every detail whether or not indicated on the Drawings or specified. Consequently, the Contractor is responsible for all details, devices, accessories and special construction necessary to properly install, adjust, test, and place in successful and continuous operation the engine-generator set.

C. Use materials which are new, unused, and as specified, or, if not specifically indicated, the best and most suitable of their kinds for the purpose intended, and for the design and expected conditions of service, subject to the approval of the Engineer.

D. Provide workmanship that is first class in every respect. Employ workers thoroughly experienced in such work. A neat and workmanlike appearance in the finished work shall be required.

E. All materials used must bear the inspection labels of the Underwriter's Laboratories, if the material is of a class inspected by the Laboratory.

F. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

G. The engine generator sets shall fully comply with all current Environmental Protection Agency (EPA) emission regulations including, but not limited to, the New Source Performance Standards (NSPS) for stationary and non-road generator sets. The engine generator set(s) must meet the EPA new source performance requirements required at the time the engine generator set(s) submittal is approved by the engineer. Engines manufactured previous to the submittal approval date that do not meet the current regulated emissions levels are not acceptable.

H. Reference Section 16000 - Basic Electrical Requirements, and Section 16496, Automatic Transfer Switch.

1.02 CODES AND STANDARDS

A. The packaged engine-generator system shall comply with the following Codes and Standards as a minimum:

1. NEMA MG1, Motors and Generators.

2. NEMA MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators.

3. ISO STD 8528, Reciprocating Internal Combustion Engines.

4. ISO STD 3046, Performance Standard for Reciprocating Internal Combustion Engines.

5. NFPA 30, Flammable and Combustible Liquids Code.

6. NFPA 37, Standard for Installation and use of Stationary Combustible Engine and Gas Turbines.

7. NFPA 70, National Electrical Code

8. NFPA 70E, Standard for Electrical Safety in the Workplace

9. NFPA 110, Standard for Emergency and Standby Power Systems.

10. UL 508, Industrial Control Equipment.

11. EGSA, Electrical Generating Systems Association.

12. UL 2200 – Stationary Engine Generator Assemblies

13. ANSI C57, Dry-Type Transformers.

14. UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.

1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

3. Reports of Certified Shop and Field Tests

4. Operation and Maintenance Manuals

5. Manufacturer's Field Start-up Report

6. Manufacturer's Representative's Installation Certification

7. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings for each engine-generator set shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter “C”, “D”, or “E” shall be typed or written in. The letter “C” shall be for full compliance with the requirement. The letter “D” shall be for a deviation from the requirement. The letter “E” shall be for taking exception to a requirement. Any requirements with the letter “D” or “E” beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this specification section.

2. Manufacturers printed specification sheets showing critical engine and generator set specifications including the following:

a. Dimensions, and weights

b. Guaranteed fuel consumption at 25%, 50%, 75% and 100% of full rated load

c. Engine bhp available

d. Brake Mean Effective Pressure (BMEP)

e. Engine jacket water heat rejection

f. Exhaust flow rate and temperature at 100% of rated load

g. Ventilation and combustion air requirements

h. Exhaust backpressure limitation

i. Liquid refill capacities

j. Voltage regulation characteristics

k. Guaranteed noise levels

3. Alternator technical electrical data, including, but not limited to:

a. Alternator efficiency at 50%, 75%, and 100% load

b. Telephone Interference Factor (TIF)

c. Harmonic waveform distortion

d. Type of winding insulation and generator temperature rise

e. Per unit subtransient impedance X'' and X/R ratios for positive, negative, and zero sequences

f. Transient reactance (Xd')

g. Synchronous reactance (Xd)

h. Sub transient time constant (Td'')

i. Transient time constant (Td)

j. DC time constant (Tdc)

k. Decrement curve

4. Manufacturer's printed warranty statement of the engine and generator set showing single source responsibility by the engine manufacturer.

5. Generator control panel equipment and features. Include a written explanation of the auto start/stop logic and operation.

6. Engine-generator set and accessory product data sheets including, but not limited to, the following:

a. Alternator strip heater

b. Radiator

c. Seismically rated vibration isolators

d. Flexible exhaust coupling

e. Exhaust silencer

f. Batteries

g. Battery charger

h. Engine manufacturers shutdown contactors

i. Jacket coolant heater

j. Fuel cooler

k. Fuel tank(s) and pump(s)

l. Fuel level devices

m. Output circuit breaker and trip unit

n. Conduit

o. Wire and Cable

p. Wiring Devices

q. Lighting

r. Panelboards/combination power unit

7. Standard dealer preventative maintenance contract for review and possible adoption under a separate contract. Dealer must have existing contracts and personnel and contractual detailed performance information available.

8. Normal operating ranges for systems temperature, pressure and speed.

9. Manufacturer's part number for the engine and generator operation guide, parts book, service manual, warranty policy, and installation guide.

10. Location of other similar units showing compliance with the experience requirements specified herein.

11. Phone numbers of twenty-four (24) hour products support contacts and locations.

12. Drawing showing right hand, left hand, and top views of proposed assembly; battery rack, isolators, exhaust silencer, conduit stub up locations, and flexible fittings; wiring schematics, interconnection diagrams (point to point), and written description of engine generator controls and alarm circuits.

13. Control panel layout drawings and wiring diagrams.

14. Drawings and specifications for base-mounted fuel storage tank and leak detection system.

15. EPA Certificate of Conformity for Exhaust Emissions

16. Detailed drawings showing plan, front, and side views as well as appropriate section views of the weatherproof, engine-generator enclosure. Include product data sheets for all appurtenances (e.g. exhaust fan, thermostat, lighting, switches, receptacles, combination power unit, etc.) to be furnished and installed in the enclosure. Drawings shall be of sufficient detail to assure proper installation by the Contractor.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.04 REPORTS OF CERTIFIED SHOP AND FIELD TESTS

A. Submit two (2) certified copies of all test reports. This includes all shop tests and field tests. Certified shop test reports for prototype engine-generator sets are unacceptable. The manufacturer's serial number for the actual engine-generator set furnished for this project shall appear on all test reports.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Two (2) preliminary copies of Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals shall be provided to the Engineer not more than 10 days after the equipment arrives on the project site.

B. The preliminary manuals shall be reviewed by the Engineer prior to the Contractor submitting final copies for distribution to the Owner. Following review of the preliminary copies of the Operation and Maintenance Manuals, one (1) copy will be returned to the Contractor with required revisions noted, or the acceptance of the Engineer noted.

C. Manuals shall contain complete information in connection with assembly, operation, lubrication, adjustment, wiring diagrams and schematics, maintenance, and repair, including detailed parts lists with drawings or photographs identifying the parts. Manuals shall contain all information submitted as part of the shop drawing review process.

D. Manuals furnished shall be assembled and bound in separate volumes, by major equipment items or trades, and properly indexed to facilitate locating any required information. In addition, manuals should be labeled in the front cover with the project, name, equipment description, and manufacturer contract information.

E. Engineer and the Owner shall be the sole judge of the acceptability and completeness of the manuals and may reject any submittal for insufficient information included, incorrect references and/or the manner in which the material is assembled.

F. Following the Engineer's review of the preliminary manuals, the Contractor shall submit five (5) paper copies and two (2) electronic copies of the final Operation and Maintenance Manuals to the Owner. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents, as well as any changes made during installation. Failure of the final manuals to reflect the required revisions noted by the

Engineer as well as changes made during installation will result in the manuals being returned to the Contractor. Acceptable final Operation and Maintenance Manuals shall be provided not more than one (1) month after receipt of the Engineer's comments.

1.06 SPARE PARTS

A. Routine maintenance and adjustments shall be performed without the use of special tools or instruments. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts for each engine-generator set:

No. Required	Description
1	Set of Fuel Oil Particulate Filters
1	Set of Air Filters
1	Set of Lube Oil Filters
1	Set of Fuel Oil/Water Separator Filters
1	Set of Coolant Filters

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts list, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

F. The dealer shall have sufficient parts inventory to maintain over-the-counter availability of at least 90% of any required part and 100% availability within 48 hours.

1.07 IDENTIFICATION

A. Each engine-generator set shall be identified with the identification name/number indicated on the Drawings (e.g., Generator No. 1, Generator No. 2, etc.). A nameplate shall be securely affixed in a conspicuous place on the generator main circuit breaker or output termination box enclosure. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.08 WARRANTY TERMS

A. The manufacturer's and Dealer's warranty shall in no event be for a period of less than two (2) years or two-thousand (2,000) hours of operation, whichever comes first, from date of delivery of equipment to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, coolant, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified shall be rejected in their entirety.

B. Provided warranty shall cover all equipment included in the scope of supply. This warranty shall include, but is not limited to, the following:

1. Engine-generator set and respective auxiliary equipment

2. All controls for the engine-generator set

C. Batteries shall be provided with two (2) year full replacement guarantee, and a pro-rated replacement schedule thereafter.

1.09 OIL SAMPLING KIT

A. The generator set supplier shall provide an oil sampling analysis kit which operating personnel shall utilize for scheduled oil sampling. All equipment needed to take oil samples shall be provided in a kit and shall include the following:

1	Sample extraction gun
10	Bottles
10	Postage-paid mailers
1	Written instructions

An additional oil sampling kit shall be made available to the Owner to continue the sampling when the above specified kit has been depleted. All kits in addition to that specified above shall be at an additional cost to the Owner, if the Owner desires to continue the sampling service.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Consideration will be given only to the equipment of those manufacturers who have furnished comparable size diesel engine-generator sets for at least two similar installations that have been in regular successful operation for not less than five (5) years.

C. The engine-generator set manufacturers shall be Cummins, Caterpillar, MTU Onsite Energy, Kohler, or approved equal. The engine-generator set manufacturer and/or dealer

shall be responsible for the entire engine-generator package including the engine-generator set with all accessories and equipment specified herein and all other devices required for a complete and operable system. The generator manufacturer shall also be the manufacturer of the engine.

D. Generator List:

Description	Voltage	Min. kW	Required sKVA	Application
Conway WWPS	480 V, 3 PH, 4W	125	540	Standby
Pennsylvania Avenue WWPS	480 V, 3 PH, 4W	125	540	Standby

2.02 GENERAL DESCRIPTION

A. The engine-generator set shall be rated as specified herein and as indicated on the Drawings. It shall have the capability to operate at its standby rating for the duration of any power outage with all accessories including engine running devices, silencer, radiator, cooling fans, fuel system, and all appurtenances complete as it would be installed in the field. The Contractor shall note and take appropriate action regarding the intended operation of the engine-generator sets while connected to motor driven loads controlled by variable frequency drives (VFDs).

B. The engine-generator set shall meet current EPA and State of Virginia DEQ air quality and emission requirements and standards for standby operations.

2.03 ENGINE

A. The engine shall be diesel, 4 cycle, radiator cooled, and shall be turbocharged having an operating speed of 1800 RPM. Engine shall operate on ASTM D-975 Grade No. 2D S15 ultra-low sulfur diesel fuel. Engines requiring any other fuel type are not acceptable.

B. The engine will not be acceptable if the design is a conversion of a naturally aspirated engine to which a turbo-blower has been attached, unless the engine is certified by the manufacturer as having been analyzed and redesigned with ample provisions for increased stresses and bearing or heat loads due to increased pressures and rate of heat liberation.

C. Only engine manufacturers' standard ratings shall be acceptable. No dealer special ratings will be acceptable.

D. The specified standby kW rating shall be for continuous electrical service during interruption of the normal utility source, per NEMA standards.

E. Engine speeds shall be governed by an electronic isochronous governor that will sense generator speed and provide accurate load transient correction capability at less than 0.5 percent regulation, from no load to full load generator output.

2.04 ALTERNATOR

A. The alternator shall conform to NEMA and IEEE standards and be rated as indicated on the Drawings. The alternator shall be brushless, salient pole, 2/3 pole pitch and synchronous for operation at 480VAC, wye connected, as indicated on the Drawings. The generator shall be capable of delivering the specified SkVA (minimum) at an instantaneous voltage dip of no more than 20% voltage drop.

B. Laminations and windings shall be designed for minimum reactance, low voltage waveform distortion and maximum efficiency.

C. The main stator coils shall be random wound. Insulation shall be Class H, 125 Degree C rise according to NEMA standards. The insulation system shall be made of epoxies and polyesters which are inorganic compounds and shall prevent fungus growth.

D. The rotor shall be dynamically balanced and include amortisseur windings to minimize voltage deviations and heating effects under unbalanced load conditions.

E. Radio interference suppression (both directions) shall be provided in accordance with NEMA and IEEE Standards.

F. The alternator shall have a brushless, permanent magnet generator (PMG) excitation support system to provide input to the automatic voltage regulator to enable the alternator to support 300% of rated current for 10 seconds to allow fault clearing.

G. Waveform deviation shall not exceed 5% from true sine wave. The transient response from no load to full load in one step of the engine-generator set shall not exceed a voltage dip of 35%, a frequency dip of 20%, and shall recover to complete steady state performance within 12 seconds for both voltage and frequency. The transient response from full load to no load in one step shall not exceed a voltage overshoot of 7% and shall recover to steady state performance within 3 seconds. Transient performance shall be in accordance with ISO 8528.

H. The Telephone Influence Factor (TIF) shall be less than 50.

I. The voltage regulator shall be an adjustable, solid-state, three-phase RMS sensing, volts/hertz type. Voltage regulation shall be a minimum of +/-0.25% from no load to continuous rating. The voltage regulator shall provide +/-10% voltage adjustment. The voltage regulator shall be located within the engine control panel.

J. An alternator mounted strip heater shall be furnished and installed as part of the system. The strip heater shall be energized to prevent condensation when the engine generator set is not running.

2.05 CONTROLS

A. Engine-generator monitoring and controls shall be mounted in a single NEMA 1 (gasketed) dust-tight enclosure. A suitable accessible terminal strip having all wires properly identified shall be furnished within the enclosure. The control panel shall be mounted at a height of 4'-8" measured from the center of the panel to the equipment pad or enclosure floor.

B. The control panel shall accept a dry contact input for engine starting from remote locations. The starting and stopping of the engine-generator set shall be initiated through the control panel only. When the engine starts, starting control shall automatically disconnect cranking controls. Four (4) cranking cycles of 10 seconds "ON", 10 seconds "OFF" shall be provided. The starting controls shall prevent re-cranking for a definite time after source voltage has been reduced to a low value, or the four (4) cranking cycles have been reached without a successful start. The automatic engine starting controls shall use industrial rated control type elements throughout, and controls shall have the capability to operate at 50% battery voltage.

C. Speed sensing shall be provided to protect against accidental starter engagement with a moving flywheel. Battery charging alternation output voltage is not acceptable for this purpose.

D. A generator/exciter field circuit breaker with shunt trip device shall be furnished and installed as part of the engine generator set. Shunt trip shall be activated upon engine-generator fault conditions.

E. A main line circuit breaker as specified herein and sized as indicated on the Drawings shall be installed as a load circuit interrupting and protection device in a NEMA 1 (gasketed) dust-tight enclosure. The circuit breaker shall be provided with adjustable long-time, short-time, and instantaneous settings. The circuit breaker shall contain an electronic trip unit with ground fault. It shall operate both manually for normal operation and automatically for protection against overload or short circuits. Generator/exciter field circuit breakers are not acceptable for this service.

   1. The circuit-breakers described above shall be manufactured and tested in accordance with U.L. and NEMA AB1 standards. Their interrupting rating shall be suitable for the available fault current. All electrical ratings shall be suitable for the application.

F. Engine-generator monitoring and control shall be provided using a microprocessor based control panel complete with an LCD display. The devices necessary for automatic starting shall be on the engine and in the engine control panel. The following hardware (minimum) shall be provided on the front of the control panel; the use of the LCD display and keypad to accomplish the same function is not acceptable:

   1. Keyed engine control mode switch (Run-Off-Auto)

   2. Large, red emergency stop pushbutton

   3. Generator voltage adjust potentiometer

   4. Generator frequency adjust potentiometer

G. The following parameters (minimum) shall be shown on the LCD display or otherwise be indicated at the control panel:

   1. Engine oil pressure

   2. Coolant temperature

3. Generator output voltage

4. Generator output current

5. Generator elapsed run time

6. Generator output frequency

7. Engine run

8. Engine fail

9. Low coolant temperature

10. Pre-high engine temperature

11. Pre-low fuel level

12. Engine speed (RPM)

H. The following events (minimum) shall cause an immediate shutdown of the engine-generator set if it operating, or prevent starting if it is not operating. The specific event that causes the shutdown/prevents starting shall be shown on the LCD display or otherwise be indicated at the control panel. A reset shall be required to clear the fault and allow the unit to operate:

1. Engine coolant high temperature

2. Engine low oil pressure

3. Low fuel level

4. Engine overspeed

5. Engine overcrank

6. Engine tried to start but failed

7. Low coolant level

I. Generator shall be provided with an externally mounted emergency shutdown pushbutton.

J. The generator control panel shall have Form C dry contacts rated 5A (minimum) at 120VAC/24VDC for the following signals:

1. Engine coolant high temperature

2. Engine low oil pressure

3. Pre-low fuel level

4. Low fuel level

5. Engine overspeed

6. Engine overcrank

7. Engine tried to start but failed

8. Low coolant level

9. Engine fail

10. Engine run

11. Fuel Tank Leak Alarm

The normally closed (NC) contacts for all of the above signals (except engine run and Pre-low fuel level) shall be wired in series to provide a common "Generator System Failure" alarm for remote indication. Other contacts shall also be wired as a part of this alarm as specified elsewhere herein.

2.06 ENGINE ACCESSORIES

A. Furnish and install the engine with all accessory equipment and appurtenances which are required for proper operation, including the following:

1. Heavy duty dry type air filter with restriction indicator

2. Heavy duty lubricating oil filter, bypass type, with replaceable absorbent-type elements

3. Lubricating oil cooler

4. Heavy duty fuel oil filter

5. Fuel oil fuel/water separator

6. Heavy duty crankcase vapor coalescer

2.07 MOUNTING

A. Couple the engine and generator together through a flexible, non-backlash type, all metal coupling which overcomes all normal misalignment stresses and transmits full engine torque with ample safety factor. Also provide flexible connections for piping connections.

2.08 COOLING SYSTEM

A. Provide a radiator manufactured of a non-corrosive material mounted on the engine. The

radiator core shall be coated with a corrosion resistant coating. Corrosion resistant coating shall be a corrosion resistant baked phenolic coating or similar.

B. Connect the radiator to the engine internal cooling system with flexible piping. Furnish appropriately sized coolant expansion tank for the cooling system.

C. The engine shall be cooled through a radiator sized to continuously maintain safe operation at full load and at 105°F outside ambient air with 50% ethylene glycol coolant. A blower type fan and low noise fan drive and controls shall be furnished. The fan and all rotating members and drive belts shall be guarded and meet OSHA standards. Proof of 105°F ambient temperature capability shall be required.

D. Coolant

1. After the cooling system is flushed and cleaned, provide an initial fill of coolant consisting of 50% ethylene glycol. An anti-corrosion treatment shall be added during the initial fill.

2. The coolant shall meet the requirements of the generator manufacturer including corrosion inhibitors provided in the coolant to protect the engine cooling system.

E. The engine shall be equipped with coolant heaters. Heaters shall be in accordance with the following:

1. Unit mounted thermal circulation type coolant heater with coolant recirculation pump shall be furnished to maintain engine jacket coolant temperature as recommended by manufacturer in a 3 phase, ambient temperature of minus 20°F. The heater shall be 208 VAC, 60 hertz, 3-phase, thermostatically controlled.

2. The heater shall be of sufficient capacity to keep the coolant at a suitable temperature for trouble-free starting.

3. Each heater shall be provided with a suitable contactor to automatically disconnect the heater when the engine is started.

2.09 ENGINE STARTING AND CHARGING SYSTEM

A. Engine starting batteries shall be sealed, lead-acid type, rated 12 volts, wired for 24 v starting batteries shall have adequate capacity for rolling the engine for five (5), ten (10) second cycles without starting, and then operating the control devices in the local generator controls for two (2) hours. The batteries shall be mounted on a suitable non-corrosive rack. Batteries shall have battery cables with lugs and shall be provided with lugs for connection to the battery charger.

B. Battery charger shall be a U.L. 1236 listed, automatic, solid-state battery charger, 20 A (min.) current limited, ±2% voltage regulation, ±10% line voltage variation, automatic float equalizing system, DC voltmeter, and DC ammeter. Provide a Form C unpowered (dry) contact to indicate a low battery alarm condition.

C. In addition, the engine shall be provided with an engine battery charging alternator that

automatically changes the starting batteries during engine operation.

2.10 EXHAUST SILENCER

A. Furnish and install an exhaust silencer. Silencers shall be of super critical type and sized to produce a high degree of silencing. Reference the sound attenuation requirements specified herein.

B. Connect the silencer to the engine exhaust manifold with a high corrosion and temperature resistant stainless steel flexible convoluted exhaust pipe. Use flange-type connections. Provide a taper-cut tail pipe complete with rain cap to exhaust the gases to the atmosphere.

C. The silencer (if installed inside), exhaust piping, and expansion fittings, including collector box, shall be completely covered with a removable insulation blanket in order to protect operating personnel and to reduce noise. Insulation shall be of composite fiberglass and stainless steel construction capable of withstanding 1200°F continuously. The insulation blankets shall be tailored and custom fabricated to fit the contours of the manifolds. Average weight of the insulating blanket shall be 1.5 psf. Insulation shall conform to MIL-1-16411D, Type II and shall be custom fabricated to fit the contours of the components.

D. The silencer system shall be designed, furnished, and installed to prevent moisture and condensation from corroding the silencer.

E. All components of the exhaust system shall be of 316 stainless steel.

2.11 WIRING

A. Furnish and install internal wiring in the engine-generator set. All internal wiring between the generator and engine-generator control panel, the on-board power source and all accessories shall be provided.

2.12 AUTOMATIC TRANSFER SWITCH

A. Furnish and install an automatic transfer switch as indicated on the Drawings and specified in Section 16496, Automatic Transfer Switch. The switch and its operation shall be considered to be part of the standby generator system.

2.13 BASE MOUNTED FUEL TANK

A. The generator set shall be supplied with a U.L.-142 listed base mounted, double walled fuel tank of sufficient capacity to operate the engine-generator set at 60% load for 168 hours, 1100 gallons minimum. Outer wall shall meet the requirements for a secondary containment tank. The tank, painted in a color as selected by the Owner, shall be fabricated from steel with a rupture basin and leak detector system. The alarm and indicator for the leak detection shall be mounted in the location shown on the Drawing and a contact for remote indication of a fuel leak condition shall be provided. This contact shall be wired as part of a common "Generator System Failure" alarm.

B. A level device shall also be furnished and installed to provide a local (generator control panel) and remote indication of pre-low fuel tank level and low fuel tank level. The pre-low

fuel tank level shall activate a set of dry contacts for remote alarm indication. The low fuel tank level alarm shall shut down the engine to prevent the fuel level from dropping below the fuel pickup piping in the fuel tank. The pre-low fuel level alarm shall activate when only [6] hours of fuel for full load operation remains in the fuel tank. The remote low fuel tank level alarm shall be wired separate from the "Generator System Failure" alarm.

C. The tank shall be supplied with all necessary fuel supply, return, vent, and fill fittings and a fuel level gauge. The lockable fill port and level gauge shall be easily accessible from outside the enclosure. Provide a valve that automatically closes the fuel fill inlet when the tank level reaches 95% of its capacity. The vent line shall be piped to the outside and be equipped with a fill whistle.

D. The underside of the tank shall not be in contact with the mounting surface (concrete pad).

2.14 WEATHERPROOF ENGINE - GENERATOR ENCLOSURE

A. Furnish and install an outdoor, weather-protective housing. The housing shall be furnished complete with a full sub-base floor resulting in complete enclosure. The enclosure shall be factory-assembled to the engine-generator set base and radiator cowling. Lifting eyes shall be provided. Housing shall provide ample airflow for generator set operation. The housing shall be constructed of 12 gauge (minimum) aluminum or 14 gauge (minimum) galvanized steel, reinforced to be vibration free in the operating mode. The housing shall have removable panel doors and rear control panel access door. All doors shall be lockable. All steel sheet metal shall be primed for corrosion protection and finish painted in a color as selected by the Owner. Roof shall be peaked to allow drainage of rain water. Unit shall have sufficient guards to prevent entrance by small animals. Batteries shall fit inside enclosure and alongside the engine (batteries under the generator are not acceptable). Unit shall have engine coolant and oil drains piped to outside the unit to facilitate maintenance. Each drain line shall have a valve located near the fluid source.

B. A “Skin-tight” housing shall be provided. No walk-around access is required within the enclosure; however, adequate working clearance shall be provided as required by the NEC. Provide access doors so that when opened, adequate working clearance is achieved in front of electrical equipment. Doors shall be provided with lift-off style hinges to allow full removal of the enclosure door for easier maintenance and access.

C. Enclosure shall be sound attenuated to provide sound level as specified herein.

D. Provide a power distribution box for terminating the power circuits run within the generator enclosures. Coordinate incoming circuit sizes with installing Contractor.

E. All hardware (nuts, bolts, screws, washers, etc.) that is installed on the exterior of the generator enclosure shall be stainless steel. Galvanized steel hardware is not acceptable.

F. Linear fluorescent or LED lighting shall be provided in sufficient quantity to maintain 20 foot-candles of illumination at floor level and shall be suitable for operation in cold weather. Compact fluorescent lighting fixtures are not acceptable. Interior lighting shall be controlled by 3-way light switches located at each door. Reference Section 16141.

G. Convenience receptacles shall be furnished at each door within the enclosure. Receptacles

shall be 125V, 20A, two-pole, three wire grounded type. Reference Section 16141.

H. Conduit and wire shall be in accordance with Sections 16111 and 16123, respectively.

I. All air intake louvers shall be furnished with rain guards or designed to eliminate water intrusion to the interior of the enclosure when the generator is operating at full load (maximum airflow) during rain events.

2.15 ACCESS STAIRS AND HANDRAIL

A. Aluminum grating platforms, ladders and aluminum handrails shall be provided on each side of generator to allow access for operation or maintenance. With sufficient dimensions to facilitated operation maintenance. The aluminum ladder shall be as specified in Specification Section 05515 – Ladders. The aluminum handrail shall be as specified in Section 05520 – Handrails and Railings. The aluminum grating shall be as specified in Section 05531 – Grating, Access Hatches, and Access Doors. The Contractor shall extend the generator concrete pad as necessary to accommodate the installation of the aluminum platforms and ladders. The platform shall be designed and signed and sealed by an Engineer licensed in the Commonwealth of Virginia.

2.16 SOUND ATTENUATION

A. Extreme care shall be exercised in providing equipment for and setting the engine-generator in place to guard against excessive noise transmission and vibrations. Fasten to the underside of the skids seismically-rated spring type isolators.

B. The engine-generator enclosure shall be designed, furnished, and installed to reduce source noise to 69 dB(A) as measured at seven (7) meters from the enclosure.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The standby generator system shall be furnished and installed as indicated on the Drawings and as recommended by the equipment manufacturer.

B. The initial filling of the fuel storage tank shall be provided by the Contractor. Fuel tank shall be filled to its full capacity. At the conclusion of all field testing, the Contractor shall fill the fuel storage tank back to its full capacity. Fuel shall be ultra-low sulfur diesel Grade No. 2D S15 in accordance with ASTM D-975. Fuel shall be new and free from contaminants and water.

3.02 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified generator manufacturer's factory-trained technical representative who shall adequately supervise the installation and of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this

certification is accepted by the Owner.

B. The manufacturer's technical representative shall perform all startup and field testing of the generator assembly as specified herein.

C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of four (4) hours each. Training shall not take place until after the generator has been installed and tested. Training shall be conducted at times coordinated with the Owner and shall occur during the same week as the training specified in Section 16496 – Automatic Transfer Switch.

D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One (1) trip of one (1) working day to perform startup of the engine-generator set.

2. One (1) trip of two (1) working days to perform the field testing of the engine-generator set.

3. One (1) trip of one (1) working day to perform training as specified herein.

E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

3.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Certified Shop Tests

a. Fully test the engine-generator set with all accessories in the manufacturer's plant before shipment. Tests shall be conducted through the use of balanced, three-phase, dry-type, resistive load banks.

b. Record complete test data for frequency, amperes, volts, power factor, exhaust temperature, coolant temperature, and oil pressure.

c. The manufacturer shall conduct a shop test run of at least six (6) consecutive hours for the set under the following conditions of load, in the following order:

3 hours - full load
1 hour - 3/4 load

1 hour - 1/2 load
1 hour - 1/4 load

d. Fuel, lubricants, and other fluids as required for the shop tests shall be furnished by the manufacturer.

3. Field Tests

a. Field tests shall be performed by the generator manufacturer's technical representative. The Contractor shall obtain from the manufacturer and submit a detailed field test plan and procedures documenting the intended field test program.

b. In the presence of the Owner's Representative and Owner, the representative shall inspect, adjust, and test the entire system after installation and leave in good working order. Field tests specific to each generator shall be conducted after the entire engine-generator system is installed including, but not limited to, the following: diesel fuel tanks including leak detection, exhaust silencer, radiators, enclosures, batteries, and all other equipment included in the complete system.

c. Field test the generator enclosure to ensure the enclosure performs as specified herein. The generator enclosure field tests shall include water tests to confirm the enclosure does not leak and that the air intake louvers eliminate water intrusion to the interior of the generator enclosure when the generator is operating at its full load capacity (maximum airflow). A garden hose shall be used to simulate falling rain for this test. Water supply and garden hose will be provided by the Owner for this test.

d. Field test, as far as practicable, all control, shutdown, and alarm circuits. Document the successful completion of these tests as witnessed by the Owner and the Owner's Representative.

e. Generator load tests shall be conducted through the use of balanced, three-phase, dry-type, reactive (0.8 power factor) load banks. Conduct a continuous run test using the load bank without shutdown for the engine-generator set under the following load conditions (in this specific order) and in the presence of the Owner and Owner's Representative:

5 hours, full load
1 hour, 3/4 load
1 hour, 1/2 load
1 hour, 1/4 load

Record complete test data for frequency, amperes, volts, power factor, exhaust temperature, coolant temperature, and oil pressure every 15 minutes during the continuous run test. If any failures, malfunctions, and/or shutdowns occur during this test, the problems shall be fixed and the test shall be restarted. The test shall not be considered complete until the generator has operated for eight (8) consecutive hours without any

shutdowns under the conditions listed above.

f. After successful completion of the load bank tests, the generator system shall then be operated for a minimum of four (4) hours with plant loads during a time period when the plant is operating at average demand. The same data shall be recorded at 15 minute intervals for this load test as for the load bank test.

g. All fuel, lubricants, and other fluids required to complete all field tests shall be paid for by the Contractor.

3.04 PAINTING

A. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

- END OF SECTION –

SECTION 16902

ELECTRIC CONTROLS AND RELAYS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.

B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.

C. Reference Section 16000, Basic Electrical Requirements and Section 16195, Electrical Identification.

1.02 CODES AND STANDARDS

A. Products specified herein shall be in conformance with or listed to the following standards as applicable:

1. NEMA 250 – Enclosures for Electrical Equipment

2. UL 508A – Standard for Industrial Control Panels

3. UL-1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

4. ANSI/ISA 12.12.01-2013 – Nonincendive Electrical Equipment for use in Class I and II, Division II Hazardous (Classified) locations.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

B. Each submittal shall be identified by the applicable specification section.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. In addition to the manufacturer recommended spare parts, the following spare parts shall be provided for the local control stations:

1. One (1) contact block of each type furnished on the project

2. One (1) indicating light lens of each color furnished on the project

3. One (1) LED lamp of each color furnished on the project

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

PART 2 -- PRODUCTS

2.01 CONTROL COMPONENTS

A. Manufacturers

1. Control components shall be manufactured by Eaton, The Square D Company, General Electric, Allen-Bradley, Siemens Energy and Automation, or Engineer approved equal.

B. Pilot Devices

1. General

a. All pilot devices shall be provided with a legend plate. Legend plates shall have a white background and black lettering and indicate the function of the respective pilot device. The text shown on the Drawings or indicated in the specifications shall be used as the basis for legend plate engraving (i.e. HAND-OFF-AUTO, RUN, EMERGENCY STOP, etc).

b. All pilot devices shall be selected and properly installed to maintain the NEMA 250 rating of the enclosure in which they are installed. All pilot devices shall be UL 508 Listed.

c. All pilot devices shall be 30.5mm in diameter, unless otherwise indicated. 22mm devices are not acceptable.

d. Pilot devices for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

e. In Class 1 Division 2 hazardous locations, pilot devices shall be the hermetically-sealed type, constructed in accordance with ANSI/ISA 12.12.01.

2. Pushbuttons

a. Pushbuttons shall be non-illuminated, black in color, and have momentary style operation unless otherwise indicated on the Drawings.

b. Pushbuttons shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each pushbutton. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

c. Pushbuttons shall be provided with a full guard around the perimeter of the button. Where a lockout style pushbutton is specified or indicated on the Drawings, provide a padlockable guard.

3. Selector Switches

a. Selector switches shall be non-illuminated, black in color, and have the number of maintained positions as indicated on the Drawings and as required. Handles shall be the extended type that provide a greater surface area for operation.

b. Selector switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each selector switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

c. Where indicated in the Drawings or Specifications, provide spring return positions.

d. Selector switches shall be provided with an indexing component that fits into the keyed portion of the cutout for the device and prevents the switch from spinning when operated.

4. Indicating Lights

a. Indicating lights shall LED type, with the proper voltage rating to suit the application, and push-to-test feature.

b. Indicating light lens colors shall be as required in equipment specifications and/or as indicated on the Drawings. If lens colors are not indicated, the following colors shall be used:

i. Red - "Run", "On", “Open”

ii. Green - "Off", “Closed”

iii. Amber - "Alarm", "Fail"

iv. White - “Control Power On”

5. Emergency Stop and Tagline Switches

a. Emergency stop switches shall be non-illuminated, red in color, with a minimum 35mm diameter mushroom head. Once activated, switch shall maintain its position and require a manual pull to release/reset.

b. Tagline switches shall have a plunger that activates upon tension from the associated safety cable. Once activated, switch shall maintain its position and require a manual release/reset.

c. Emergency stop and tagline switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as

required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

C. Relays and Timers

1. General

a. Relays and timers shall be furnished with an integral pilot light for positive indication of coil energization.

b. Relays and timers shall have tubular pin style terminals with matching 11-pin DIN rail mount socket. Spade or blade style terminals are not acceptable.

c. Relays and timers for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

2. Control and Pilot Relays

a. Miniature or “ice-cube” type relays are not acceptable.

b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.

c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have 3-pole, double-throw (3PDT) contact arrangement.

3. Time Delay Relays

a. Timers delay relays shall utilize electronic timing technology. Mechanical timing devices are not acceptable.

b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.

c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have double-pole double-throw (DPDT) contact arrangement.

d. Time delay ranges shall be as indicated on the Drawings and/or as required to suit the application. Timing range shall be adjustable from the front of the relay. On delay and off delay timer configurations shall be provided as indicated on the Drawings and/or as required to suit the application.

4. Elapsed Time Meters

a. Elapsed time meters shall be non-resettable type with no less than a 4 digit display. Coil voltage shall be as required to suit the application and/or as indicated on the Drawings.

D. Control Terminal Blocks

1. Control terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or subpanel. Terminals shall be tubular screw type with pressure plate that will accommodate wire size range of #22 - #8 AWG.

2. Control terminal blocks shall be single tier with a minimum rating of 600 volts and 20A. Separate terminal strips shall be provided for each type of control used (i.e. 120VAC vs. 24VDC). Quantity of terminals shall be provided as required to suit the application. In addition, there shall be a sufficient quantity of terminals for the termination of all spare conductors.

3. Terminals shall be marked with a permanent, continuous marking strip, with each terminal numbered. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

2.02 LOCAL CONTROL STATIONS

A. Local control stations shall be furnished and installed complete with pushbuttons, selector switches, indicating lights, and other devices as indicated on the Drawings.

B. Specific devices installed in local control stations shall be provided in accordance with the requirements specified elsewhere in this Section.

C. In non-hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	**ENCLOSURE TYPE AND MATERIAL**
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Die Cast Zinc
Indoor Dry Non-process Area	NEMA 12, Die Cast Zinc
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or Thermoplastic Polyester
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

D. In hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

E. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs. Conduit hubs shall be external to the enclosure.

F. Local control stations for use in non-hazardous locations shall be UL-508 Listed. Local control stations for use in Class 1 Division 1 and Class 2 Divisions 1/2 hazardous locations shall be UL-1203 Listed. Local control stations for use in Class 1 Division 2 hazardous locations shall be in accordance with ANSI/ISA 12.12.01-2013.

G. Provide a nameplate on each local control station in accordance with Section 16195, Electrical Identification. The name and/or number of the equipment associated with each control station shall be engraved on the nameplate, followed by the words “LOCAL CONTROL STATION”.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Local control stations shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

B. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices.

C. Pilot devices shall be properly bonded to the equipment enclosure door where they are installed. If proper bonding cannot be achieved through the locknuts that affix the device in place, a green colored bonding screw shall be provided on the pilot device. The bonding screw shall be bonded to the equipment enclosure through the use of an insulated green bonding conductor.

D. Local control station covers shall be bonded to the local control station enclosure through the use of an insulated green bonding conductor.

E. Wiring to devices at each local control station shall be provided with enough slack to permit the local control station cover to be removed and pulled at least 6 inches away from the enclosure.

F. Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors. Terminal strips, relays, timers, and similar devices shall not be installed on the side walls of panel/cabinet interiors without written permission from the Engineer.

- END OF SECTION -

SECTION 17000

CONTROL AND INFORMATION SYSTEM
SCOPE AND GENERAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SCOPE

A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, all components, system installation services, as well as all required and specified ancillary services in connection with the Instrumentation, Control and Information System. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified. The system shall include all measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, remote telemetry units, signal and data transmission systems, interconnecting wiring and such accessories as shown, specified, and/or required to provide the functions indicated.

B. The scope of the work to be performed under this Division includes but is not limited to the following:

1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.

2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.

3. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Division 17.

4. Furnish and install digital control system hardware and software as specified in Division 17.

    a. Two (2) new PLCs shall be provided and installed in total, at the following sites: one (1) at Pennsylvania Avenue WWPS and one (1) at Conway WWPS.

    b. Each new PLC shall contain an uninterruptable power supply in accordance with Section 17190.

5. Final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under Division 17.

6. Furnish, install and terminate all special cables (instruments, printers, telemetry, etc.). Furnish and terminate control system communication network cables.

7. Furnish and install surge protection devices for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 16.

8. Coordinate grounding requirements with the electrical subcontractor for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division. Terminate grounding system cables at all equipment provided under this Division.

9. Provide system testing, calibration, training and startup services as specified herein and as required to make all systems fully operational.

C. Services to be provided by CIM Automation Systems - M.C.Dean, under the Contractor:

1. Modify existing SCADA screens at the Opequon Water Reclamation Facility as specified under this Division.

D. Hardware and services to be provided by Owner (City of Winchester):

1. Owner will provide a new cellular telemetry system, in its entirety. This includes but is not limited to the following components, cellular modem, antenna, cabling, surge protection. Cellular components shall be provided on time for installation by the Contractor into the new control panel. Contractor shall coordinate this system with the ICSS.

E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested and calibrated as specified under other Divisions.

B. Additional and related work performed under Division 16 includes the following:

1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for all equipment, control panels and accessories furnished under Division 17.

2. Conduit and raceways for all instrumentation and control system signal wiring, grounding systems, special cables and communication network cables.

3. Instrumentation and control system signal wiring.

4. Install control system communication network cables.

5. Furnish and install grounding systems for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under Division 17. Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor.

6. Termination of all instrumentation and control system signal wiring at all equipment furnished under other divisions of the Specifications.

7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g. panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.

B. In order to centralize responsibility, it is required that all equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.

C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems and shall provide for the services of a qualified installation engineer to supervise all activities required to place the completed facility in stable operation under full digital control.

D. The instrumentation and control system shall be capable of simultaneously implementing all real-time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of any system component.

E. Control system inputs and outputs are listed in the Input/Output Schedule. This information, together with the functional control descriptions, process and instrumentation diagrams, and electrical control schematics, describes the real-time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.

F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field-mounted equipment provided by others. The instrumentation subcontractor shall examine the

mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the control and information system. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.

G. The instrumentation subcontractor shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.

H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.

I. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

J. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The instrumentation subcontractor and his equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

K. The terms "Instrumentation", "Instrumentation and Control System", and "Instrumentation, Control and Information System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the Specifications.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS (ICSS)

A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water and wastewater treatment facilities. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers and/or models of major hardware or software products (PLC, HMI software, LAN, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term “completed” shall mean that a project has been brought to final completion and final payment has been made. Any instrumentation and control system subcontractor that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five calendar years shall not be acceptable.

B. Acceptable instrumentation and control system subcontractors shall be CIM Automation Systems - M.C.Dean, Systems East, Inc., Sherwood-Logan Controls, Inc., or equal.

1.05 DEFINITIONS

A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.

B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.

C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.

E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.

F. Availability: The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

$$A = 100 \times (MTBF/(MTBF + MTTR)) \text{ Percent}$$

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

$$A = A2 + 1 - ((1-A1) \times (1-A1))$$

where:

A1	=	availability of non-redundant device or system
A2	=	availability of device or system provided with an automatically switched backup device or system

G. Abbreviations: Specification abbreviations include the following:

A	-	Availability
ADC	-	Analog to Digital Converter

AI	-	Analog Input
AO	-	Analog Output
AVAIL	-	Available
BCD	-	Binary Coded Decimal
CSMA/CD	-	Carrier Sense Multiple Access/Collision Detect
CPU	-	Central Processing Unit
CRC	-	Cyclic Redundancy Check
CRT	-	Cathode Ray Tube
CS	-	Control Strategy
DAC	-	Digital to Analog Converter
DBMS	-	Data Base Management System
DI	-	Discrete Input
DMA	-	Direct Memory Access
DO	-	Discrete Output
DPDT	-	Double Pole, Double Throw
DVE	-	Digital to Video Electronics
EPROM	-	Erasable, Programmable Read Only Memory
FDM	-	Frequency Division Multiplexing
FSK	-	Frequency Shift Keyed
HMI	-	Human Machine Interface (Software)
I/O	-	Input/Output
LAN	-	Local Area Network
LDFW	-	Lead-Follow
MCC	-	Motor Control Center
MTBF	-	Mean Time Between Failures
MTTR	-	Mean Time To Repair
OS	-	Operating System
PAC	-	Programmable Automation Controller
PCB	-	Printed Circuit Board
PID	-	Proportional Integral and Derivative Control
PLC	-	Programmable Logic Controller
PROM	-	Programmable Read Only Memory
RAM	-	Random Access Memory
RDY	-	Ready
RMSS	-	Root Mean Square Summation

RNG	-	Running
ROM	-	Read Only Memory
RTU	-	Remote Telemetry Unit
SPDT	-	Single Pole, Double Throw
ST/SP	-	Start/Stop
TDM	-	Time Division Multiplexing
UPS	-	Uninterruptible Power Supply

H. To minimize the number of characters in words used in textual descriptions on CRT displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.06 ENVIRONMENTAL CONDITIONS

A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.

B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.

D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

PART 2 -- PRODUCTS

2.01 NAMEPLATES

A. All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the

description shall be subject to the Engineer's approval.

B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.

C. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

PART 3 -- EXECUTION

3.01 SCHEDULE OF PAYMENT

A. Payment to the Contractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System.

B. Requests for payment for materials and equipment that are not installed on site, but are required for system construction and the factory acceptance test (e.g., digital hardware), or are properly stored as described in the General and Supplementary Conditions and herein, shall be accompanied by invoices from the original supplier to the instrumentation subcontractor substantiating the cost of the materials or equipment.

C. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance test.

3.02 CLEANING

A. The Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials.

B. Upon completion of the instrumentation and control work, the Contractor shall remove all surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.03 FINAL ACCEPTANCE

A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:

1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.

2. Completion of the Availability Demonstration.

3. Completion of all specified control system training requirements.

4. Completion of all punch-list items that are significant in the opinion of the Engineer.

B. Final acceptance of the System shall mark the beginning of the extended warranty period.

- END OF SECTION -

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SECTION 17030

CONTROL AND INFORMATION SYSTEM SUBMITTALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall submit for review complete Shop Drawings for all equipment in accordance with the General Conditions and Division 1 of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 17000 – Control and Information System Scope and General Requirements

1.03 DIGITAL HARDWARE SUBMITTALS

A. Submit system block diagram(s) showing:

1. All equipment to be provided.
2. All interconnecting cable.
3. Equipment names, manufacturer, and model numbers.
4. Equipment locations.

B. Submit information for all digital equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
2. Catalog cuts, including complete part number breakdown information.
3. Complete technical, material and environmental specifications.
4. Assembly drawings.
5. Mounting requirements.
6. Color samples.
7. Nameplates.

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8. Environmental requirements during storage and operation.

1.04 SOFTWARE SUBMITTALS

A. Software submittals shall include the following as a minimum:

1. Bill of materials with software names, vendors, and complete listings of included software modules.

2. Standard manufacturer's literature describing the products.

3. Description of function of software in Control and Information System.

4. Limitations or constraints of software.

5. Minimum system (processor and memory) requirements.

6. Operation and maintenance requirements.

B. Submit information on the following software:

1. Third-party software, including:

a. Operating system.

b. Operator workstation (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).

c. Office-type products, such as spreadsheets, word processors, etc.

d. Database management software.

e. Communication software, including all applicable local and wide area network software.

f. Programmable controller programming software (where applicable).

2. Software configuration, including:

a. Graphic display organization.

b. Database configuration for operator workstations and database management system.

c. Trends.

d. System security.

e. Formats for all reports, including all required calculations.

f. Intercommunications between software products required to implement system functions.

g. Equipment backup configuration and requirements.

C. Control Strategies

1. Provide control strategy documentation that includes control strategy diagrams (block oriented logic and ladder logic diagrams, as appropriate) to describe the control of all processes. The written description shall follow the format of the functional control descriptions contained herein. The control strategy submittals shall contain the following as a minimum:

a. An overall description of the program structure and how it will meet the specified control requirements.

b. A listing of the program.

c. Extensive comments in the listings to describe program steps.

d. Equation and ladder program derivations for all specified control routines.

e. Resource (processor and memory) requirements.

f. A listing of inputs and outputs to the control strategy.

D. Application Software

1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include any add-in custom software.

E. Graphic Displays

1. Submit all graphic displays required to perform the control and operator interface functions specified herein.

2. Submit the complete set of graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.

3. Where a large number of graphic displays are required, submit an initial set of example displays for review before the complete set of displays is submitted. This initial set shall include examples of all basic graphic display design features and parameters, and is intended to allow the Contractor to obtain preliminary approval

of these features and parameters prior to beginning main graphic display production.

4. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer and the Owner. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.

5. Two of the required submittals in each revision cycle shall be full color prints of the entire set of displays. Additional sets may be in black-and-white or gray-scale.

6. Displays shall be printouts of actual process graphics implemented in the system.

1.05 CONTROL PANEL SUBMITTALS

A. Submittals shall be provided for all control panels, and shall include:

1. Exterior panel drawings with front and side views, to scale.

2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.

3. Panel area reserved for cable access and conduit entry.

4. Location plans showing each panel in its assigned location.

B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.

2. Catalog cuts, including complete part number breakdown information.

3. Complete technical, material and environmental specifications.

4. Assembly drawings.

5. Mounting requirements.

6. Color samples.

7. Nameplates.

8. Environmental requirements during storage and operation.

C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

1.06 INSTRUMENT SUBMITTALS

A. Submit information on all field instruments, including but not limited to the following:

1. Product (item) name and tag number used herein and on the Contract Drawings.

2. Catalog cuts, including complete part number breakdown information.

3. Manufacturer's complete model number.

4. Location of the device.

5. Input - output characteristics.

6. Range, size, and graduations.

7. Physical size with dimensions, NEMA enclosure classification and mounting details.

8. Materials of construction of all enclosures, wetted parts and major components.

9. Instrument or control device sizing calculations where applicable.

10. Certified calibration data on all flow metering devices.

11. Environmental requirements during storage and operation.

12. Associated surge protection devices.

1.07 WIRING AND LOOP DIAGRAMS

A. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.

B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.

C. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4, Figures 1-3, Minimum Required Items.

D. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.

1.08 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall deliver equipment operation and maintenance manuals in compliance with Section 01300 - Submittals. Operation and maintenance (O&M) manuals shall consist of two basic parts:

1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.

2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.

B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.

1. A comprehensive index.

2. A functional description of the entire system, with references to drawings and instructions.

3. A complete "as-built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

5. Full specifications on each item.

6. Detailed service, maintenance, and operation instructions for each item supplied.

7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

9. References to manufacturers' standard literature where applicable.

10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

D. The operating instructions shall clearly describe the step-by-step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.

F. The hardware maintenance documentation shall include, as a minimum, the following information:

1. Operation Information - This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

2. Preventive-Maintenance Instructions - These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.

3. Corrective-Maintenance Instructions - These instructions shall include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.

4. Parts Information - This information shall include the identification of each replaceable or field-repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between equipment numbers and manufacturer's part numbers shall be provided.

G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:

1. A program abstract that includes:

a. Program Name - The symbolic alphanumeric program name.

b. Program Title - English text identification.

c. Program Synopsis - A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by nonsoftware oriented readers.

2. A program description that shall include, but not be limited to, the following:

a. Applicable Documents - List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.

b. Input-Output - Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.

c. Processing - This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.

d. System Configuration - Describe in detail the system configuration or status required for program implementation, if appropriate.

e. Limitations and Constraints - Summarize all known or anticipated limitations of the program, if appropriate.

f. Storage - Define program storage requirements in terms of disk or RAM memory allocation.

g. Verification - Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.

h. Diagnostics - Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.

i. Malfunction Procedures - Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.

1.09 FINAL SYSTEM DOCUMENTATION

A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.

B. If any documentation or other technical information submitted is considered proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary will be used only for the construction, operation, or maintenance of the System and, to the extent permitted by law, will not be published or otherwise disclosed.

C. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected so as to describe final "as-built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.

D. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as-built software configurations.

E. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

F. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.

G. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.

H. The Owner recognizes the fact that not all possible problems related to real-time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

1.10 PROGRAMS AND SOURCE LISTINGS

A. Provide one copy of all standard, of-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.

B. Provide one copy of source listings on optical media for all custom software written specifically for this facility, all database files configured for this facility, and all control

strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

1.11 SUBMITTAL/DOCUMENTATION FORMAT

A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.

B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in Searchable Adobe Portable Document Format (.pdf).

1.12 ELECTRONIC O&M MANUALS

A. Subject to acceptance by the Owner and Engineer, the O&M information may be submitted in part or in whole in an electronic format on optical media.

B. Electronic O&M manuals shall contain information in standard formats (Searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible through the use of standard, “off-the-shelf” software such as an Internet browser.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17050

TOOLS, SUPPLIES AND SPARE PARTS - GENERAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide tools, supplies, and spare parts as specified herein for the operation and maintenance of the Control and Information System.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 17000 – Control and Information System Scope and General Requirements

PART 2 -- PRODUCTS

2.01 TOOLS

A. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Division.

B. Furnish one portable 4-20 mA, 24 VDC analog loop signal generator for calibration and testing of analog signal loops. Generator shall be furnished with rechargeable battery pack, test leads, spare battery pack, charger, carrying case and accessories. Signal generator shall be Fluke 787 ProcessMeter, or equal.

2.02 SUPPLIES

A. The Contractor shall provide supplies as specifically required in other Sections of Division 17

2.03 SPARE PARTS

A. Provide spare parts for items of control and instrumentation equipment as recommended by the manufacturer and in accordance with the Contract Documents.

B. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.

C. The Contractor shall replace all spare parts consumed during installation, testing, start-up, the system availability demonstration, and the guarantee period.

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D. Refer to individual digital hardware and instrument sections for additional requirements specific to those devices.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17060

SIGNAL COORDINATION REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall conform to the signal coordination requirements specified herein.

B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor, and the instrumentation subcontractor.

C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLC's and Control System PLC's.

D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLC's, the Control System, etc.

1.02 ANALOG SIGNAL TRANSMISSION

A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 volts D.C.

B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.

C. All cable shields shall be grounded <u>at one end only</u>, at the control panel, with terminals bonded to the panel ground bus.

D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.

E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliampere signal.

F. The Contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.

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G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.

H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

1.03 DISCRETE INPUTS

A. All discrete inputs to equipment and Control and Information System PLC's, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLC's, unless specified otherwise.

B. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC.

1.04 DISCRETE OUTPUTS

A. All discrete outputs from local control panels and Control and Information System PLC's to field devices, starters, panels, etc., shall be 24 VDC powered (sourced) from PLC's [dry contact relay outputs].

B. PLC powered discrete outputs shall energize 24 VDC pilot relay coils in the field devices, starters, panels, etc. which in turn open or close contacts in the associated control circuit. The 24 VDC relay coil, contacts, and associated control circuitry shall be furnished integral with the field device, starter, panel, etc. by the supplier and contractor furnishing the field device, starter, or panel.

C. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC's to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.

D. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

1.05 OTHER DISCRETE SIGNALS

A. Discrete signals between starters, panels, etc. where no 24 VDC power supply is available may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.

B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.

C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.

D. The above requirements shall apply to all starters and panels, regardless of supplier.

PART 2 -- PRODUCTS

2.01 PILOT RELAYS

A. Pilot relays shall be supplied with the following:

1. 24 VDC or 120 VAC coils, as required.

2. At a minimum, DPDT contacts rated at 5 A, 120 VAC or 28 VDC.

3. Sockets for 24 VDC and 120 VAC relays shall be of different configurations.

4. Clips for attachment to sockets.

5. Indicator lights that glow when the relay coil is powered.

B. Pilot relays shall be as manufactured by Square D, Allen Bradley, Potter & Brumfield, or equal.

PART 3 -- EXECUTION

(NOT USED)

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SECTION 17070

CONTROL AND INFORMATION SYSTEM TESTING - GENERAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall test the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17071 – Factory Acceptance Test

C. Section 17072 – Field Testing

1.03 SUBMITTALS

A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:

1. A schedule of all testing to be conducted.

2. A brief description of the testing to be performed

3. Test objectives.

4. Testing criteria per the Specifications.

5. Check lists and procedures for performing each of the specified tests.

6. Sample test result documentation.

7. Requirements for other parties.

1.04 GENERAL REQUIREMENTS

A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.

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B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.

C. The Contractor (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.

D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.

E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17071

FACTORY ACCEPTANCE TEST

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform a Factory Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17070 – Control and Information System Testing, General

C. Section 17072 – Field Testing

1.03 FACTORY ACCEPTANCE TEST

A. The Control and Information System equipment shall not be shipped until the Contractor receives notice of acceptability of the factory tests.

B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be approved in writing by the Engineer.

C. Each subsystem shall be fully factory tested for function and operation.

D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.

E. All hardware and software required to perform the specified testing shall be furnished by the Contractor at no additional cost to the Owner.

F. The factory testing shall demonstrate all aspects of system sizing and timing including:

1. Monitoring and control scan times at the PLC level.

2. Response times at the operator workstation level.

G. The overall system as well as individual component hardware shall be tested under conditions of power failure to ensure proper response as specified herein.

H. Operator Workstation Operation - This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:

1. Demonstrate proper operation, under both normal and abnormal conditions of the operator workstation application software (SCADA, remote alarm dial-up, etc.). This shall include demonstration of system on-line diagnostics, fail-over features, reconfiguration operations, system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.

2. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.

3. Demonstrate the configuration of the system to verify conformance with the Contract Documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.

4. The system shall be operated with data input/output with the PLC's and associated panels to prove operation of all workstation functions.

5. The testing in Items 2 and 3 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously).

I. PLC Operation - All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLC's. This shall include the following:

1. On-line and off-line diagnostics.

2. For redundant units, fail-over operation and reconfiguration.

3. System initialization and restart.

4. Network communications, including fieldbus communications where required.

5. Non-volatility of memory.

6. Operation of all control logic shall be demonstrated as described herein.

J. Process I/O Simulation - Process input/output simulation for PLC's shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process

I/O systems such as plug-in circuit cards or I/O test modules may be utilized subject to approval by the Engineer to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:

1. To provide a means of communications checkout from the operator workstations through the various levels of software in the PLC's and to the process, i.e., the simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.

2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.

3. To provide data for use at all levels of the control system at the time of system integration.

K. Control Strategy Testing - Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 17072

FIELD TESTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17070 – Control and Information System Testing, General

C. Section 17071 – Factory Acceptance Test

1.03 GENERAL REQUIREMENTS

A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:

1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in Section 17600.

2. Each final control element shall be individually tested as specified hereinafter.

3. Each control loop shall be tested as specified hereinafter.

4. Each control strategy shall be tested under automatic digital control as specified hereinafter.

5. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.

B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.

C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

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1.04 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.

C. The Contractor shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.

D. The Contractor shall ensure that the HVAC subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

1.05 FINAL CONTROL ELEMENT TESTING

A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.

B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD’s, that require turndown limits shall be initially set during this test.

C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

1.06 LOOP CHECKOUT

A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.

B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.

C. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.

D. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.

E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.07 CONTROL SYSTEM STARTUP AND TESTING

A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.

B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.

C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.

D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.

E. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.

F. A witnessed acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring points. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.

G. Each loop test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.08 FACILITY STARTUP COORDINATION

A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.

B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.

C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.

D. At least one qualified control systems technician shall be provided for control system startup and test activities (at least two when loop checkout is being performed).

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17080

QUALITY ASSURANCE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. It is the intent of these Specifications and Drawings to secure high quality in all materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Contractor shall provide equipment and services to meet this intent.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. All work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State, local and other applicable codes.

1.03 QUALITY ASSURANCE - GENERAL

A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.

B. For uniformity, only one manufacturer will be accepted for each type of product.

C. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.

D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble-free service.

E. Electronic components shall be de-rated to assure dependability and long-term stability.

F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.

G. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers.

H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

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1.05 OPTIONAL EQUIPMENT

A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

1.06 GUARANTEE

A. The instrumentation subcontractor through the Contractor shall install, maintain and guarantee the Instrumentation, Control and Information System as specified under the General Conditions and Division 1 of the Specifications. Maintenance personnel provided by the instrumentation subcontractor shall instruct the Owner's personnel in the operation, adjustment, calibration and repair of the equipment being serviced. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed and list materials used. A copy of all service reports shall be delivered to the Owner on the day the work is performed.

B. The instrumentation subcontractor shall provide the services of factory-trained service technician(s) at least twice during the guarantee period, for the purpose of performing preventive hardware maintenance.

C. Corrective hardware and software maintenance during the guarantee period shall be performed in accordance with the requirements of Division 1 and, in addition, shall meet the following requirements:

1. Corrective hardware maintenance shall be performed by factory-trained service technician(s) specifically trained to service the digital equipment provided. Technicians possessing suitable training and experience shall be provided to perform corrective maintenance on all other equipment. The hardware service technician(s) shall be available on-site within 24 working hours after notification by the Owner.

2. Corrective software maintenance shall be performed for software provided by the instrumentation subcontractor and incorporated into the system prior to the completion of system commissioning. Software service programmer(s) shall be available for consultation within four business hours and, if required, on-site within 16 business hours after notification by the Owner. Corrective software maintenance shall include the supply, installation and startup of all application software upgrades released during the guarantee period.

3. Corrective hardware and software maintenance performed during the guarantee period shall be performed at no cost to the Owner.

4. As used herein, the term "working hours" shall be defined as those of the treatment facility (seven days per week, 24 hours per day). The term "business

hours" shall be defined as the hours between 8:00 a.m. and 5:00 p.m., local time, Monday through Friday; excluding holidays.

5. The guarantee period shall commence upon final acceptance of the completed treatment facility in accordance with the provisions of the Contract Documents.

D. The instrumentation subcontractor shall submit to the Owner a proposed maintenance agreement incorporating the following features:

1. Extension of preventive hardware maintenance services as described above for a period of up to five years from the expiration of the warranty period.

2. Provisions for corrective hardware and/or software maintenance work on a will-call basis for a period of up to five years from the expiration of the warranty period. Corrective maintenance work shall be performed by properly trained personnel as described above.

E. The proposed agreement shall include provisions for payment based upon an annual fee for preventive maintenance and cost plus expenses for corrective maintenance work. The portion dealing with corrective maintenance shall be written to include corrective maintenance caused by actions of the Owner during the warranty period and shall contain clauses for re-negotiation of contract prices based upon changes in recognized economic indicators published by the United States Department of Commerce.

1.07 SHIPPING HANDLING AND STORAGE

A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract Documents, air conditioning/heating shall be provided for storage of all field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

1.08 FABRICATION

A. Fabrication of all equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. The Contractor shall provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.

C. Equipment approval at the factory only allows the equipment to be shipped to the project site. The Contractor shall provide for the proper storage, installation and satisfactory start-up and operation of the equipment to the satisfaction of the equipment manufacturer, the instrumentation subcontractor, and the Engineer.

1.09 INSTALLATION

A. All instrumentation and control system installation work, whether new construction or modifications to existing equipment/panels/structures, shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The instrumentation subcontractor shall assign a competent representative who shall provide full time coordination and supervision of all on-site instrumentation and control system construction work from commencement of construction through completion and final acceptance.

C. All labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.

D. All equipment and materials shall fit properly in their installations. Any required work to correct improperly fit installations shall be performed at no additional expense to the Owner.

E. All work shall be performed in a neat and workmanlike manner. All hardware and instrumentation shall be installed in accordance with requirements specified herein, in accordance with industry best practices, in accordance with manufacturers' recommendations, and in a manner suitable for ease of operation, inspection, and maintenance. All wiring shall be neatly bundled, run in wireway, and terminated. All spare wiring shall be neatly coiled and clearly labeled at both ends for future use by the Owner. Any work not meeting these requirements shall be corrected at no expense to the Owner.

F. Sufficient common-mode and differential-mode noise rejection shall be provided to ensure operation of the plant process control system to meet all specification requirements. General practice shall include:

1. Maintaining crossings between noisy wires and signal wires at right angles.

2. Maintaining separation between noisy wires and signal wires as wide as practical.

3. Grounding all signals, shields and power supplies at the process control unit or local control panel.

4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.

5. Eliminating cable splices. All splices in instrumentation and control system signal and network cables shall be approved in advance by the Engineer.

6. Providing a floating output for transmitters that have their own power sources.

G. DC and AC power grounding shall be performed in accordance with the digital hardware manufacturer's recommendations as well as all applicable code requirements.

H. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.

I. Power wires shall be separated from parallel-running signal wires by the following minimum spacing:

CIRCUIT VOLTAGE (VAC)	MINIMUM SPACING (IN.)
120	12
240	18
480	18
2000 and above	24

J. The Contractor shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.

K. Following acceptance of the factory tests by the Engineer, and in accordance with the construction schedule, the Contractor shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical work has been completed in the equipment rooms, MCC's, control rooms and all structural and/or mechanical work has been completed within 50 feet of equipment locations.

L. Upon completion of the above construction work, the Contractor shall request an inspection of the above-named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 17100

CONTROL AND INFORMATION SYSTEM HARDWARE, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The process control system is physically and functionally distributed between PLC equipped control panels, motor control panels, field panels, operator workstations and appurtenances.

B. Although manual control facilities shall be provided adjacent to each final control element or in local control panels, such facilities are for testing, maintenance and local monitoring purposes only and shall not be regarded as backup to the PLC-based control system.

C. PLCs may be categorized as either “process PLCs” that are provided by the instrumentation subcontractor or “equipment control PLCs” provided by equipment manufacturers for the operation of their equipment (blowers, centrifuges, chemical systems, filters, etc.). Unless otherwise specified, all PLCs provided under this Contract shall conform to the requirements specified in this Division.

D. Major plant control system digital equipment items are described in the Specifications and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17120 – Programmable Logic Controllers

B. Section 17125 – Operator Interface Terminals

C. Section 17180 – Process Control System Networks

1.03 DIGITAL HARDWARE CONFIGURATIONS

A. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. Run time and flow accumulations shall be performed at the PLC level. Except for minimal calculations related to report-specific functions such as minimum, maximum, average, etc., operator workstations shall not be used to perform calculation for the process control system. Operator workstations shall be fully independent devices, individually connected to the plant control system networks.

B. No other exceptions will be considered.

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PART 2 -- PRODUCTS

2.01 GENERAL SYSTEM HARDWARE REQUIREMENTS

A. Unless otherwise specified, all hardware shall be rated for industrial use, resistant to shock, vibration, electromagnetic interference, static discharge, and suitable for the environmental conditions described elsewhere in this Division. Commercial or office grade equipment shall not be accepted.

B. Unless otherwise specified, modular construction shall be employed to simplify maintenance and to provide for future hardware expansion. Plug-in, modular PCB's or modules shall be employed for easy removal to permit exposure of circuit wiring, components and test points. Extender boards shall be provided if necessary to permit PCB's to be completely exposed for testing purposes.

C. Keying schemes shall be used to prevent PCB misplacement.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature.

2.02 DIGITAL SYSTEM FAILURE DETECTION AND FAIL-OVER REQUIREMENTS

A. No degradation in control system performance shall occur when the system is operating in a partial failure or an equipment fail-over mode. Likewise, no degradation of system performance shall occur while a backed up system component is undergoing preventive or corrective maintenance.

B. All devices connected to the plant control system network shall be self-checking and shall report their operational status to the operator workstations as either "normal" or "failed". A graphic display based on the system architecture drawing shall be furnished with the control and information system showing this information along with current communication status of each device.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17000, Part 3.

- END OF SECTION -

SECTION 17120

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all programmable logic controllers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17060 – Signal Coordination Requirements

C. Section 17100 – Control and Information System Hardware - General

D. Section 17125 – Operator Interface Terminals

E. Section 17180 – Process Control System Networks

F. Section 17190 – Uninterruptible Power Systems

G. Section 17500 – Enclosures, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies, and Spare Parts. In addition, the following specific spare parts items shall be provided:

1. One of each type and size of module for PLC equipment furnished under this Contract.

2. One of each type and size of PLC and equipment power supply furnished under this Contract.

PART 2 -- PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS - GENERAL

A. The instrumentation subcontractor shall furnish programmable controllers (PLC's) as specified herein and as shown on the Drawings. PLC's shall be provided complete with backplane, power supply, I/O cards, special function cards, instructions, memory,

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input/output capacity, and appurtenances to provide all features and functions as described herein. No substitutions allowed.

B. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.

C. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.

D. Where applicable, the minimum PLC backplane size shall be 7 slots, not including power supply slots.

E. System configuration shall be as shown on the Control System Architecture Drawing. PLC types shall be designated on the Control System Architecture Drawing and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. Memory and processor shall be adequate for all control functions specified. PLCs shall be the following, no substitutions allowed:

1. Modicon M340

2.02 PROCESSORS

A. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Nonvolatile memory in the form of a manufacturer supplied industrial CompactFlash card or equivalent technology shall be required to maintain the entire current program and firmware of the controller in the event of power loss. The program shall be updated onto the flash memory each time a program change such as an online edit or tag value is changed. When nonvolatile memory (flash memory) is not available for certain controller models as offered by the PLC manufacturer, lithium batteries shall be used to maintain process RAM memory for at least one year in the event of power loss. The lithium battery unit shall be an externally mounted battery assembly with the highest available capacity. The PLC shall send an alarm to the plant control system if battery level is low.

B. The instruction set for the PLC shall conform to the requirements of IEC 61131-3. Each PLC shall have the capability to run all five of the standard IEC 61131-3 languages simultaneously. These five languages shall be:

1. Ladder Diagram
2. Structured Text
3. Instruction List
4. Function Block Diagram
5. Sequential Function Chart

C. Additional co-processors or modules may be necessary and shall be furnished as required to meet the functions specified herein and in Section 17950 – Functional Control Descriptions.

D. PLC processors shall be provided with substantial user program, data and logic memory to allow for future expansion of the overall system. The total memory used on each processor shall be less than 60% of available memory at project completion.

2.03 COMMUNICATIONS

A. PLC communications shall be provided as specified in Section 17180 – Process Control System Networks and as shown on the Control System Architecture Drawing.

B. In addition to a communications port for the control system network, communication ports shall be provided for any other devices required (i.e., operator interface unit) plus an additional communication port for connection to a notebook computer.

C. The PLC shall be able to support various types of fieldbus communication systems for data links to field instruments (where specified) in addition to connected equipment such as power monitors, VFDs, motor protection monitors, etc. As a minimum, Profibus DP, Foundation Fieldbus, Modbus RTU Master and Slave, TCP/IP Ethernet shall be supported. The Contractor shall coordinate the efforts of the necessary parties (instrumentation subcontractor and equipment suppliers) to accomplish the required device and data table addressing between each PLC and the associated connected equipment.

D. Additional communication modules or protocol gateways may be required to support specific communication protocols required under this Contract, and shall be supplied at no extra cost to the Owner.

2.04 INPUT/OUTPUT SUBSYSTEMS

A. Input/output hardware shall be plug-in modules in associated I/O backplane/chassis or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.

B. Discrete inputs shall be 120 VAC signals (integral to the PLC) from dry field contacts. Discrete outputs shall be 120 VAC outputs sourced from the PLC, or dry relay contacts (2A minimum) as required. Refer to Section 17060 – Signal Coordination Requirements for further details of discrete signal type and voltage requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 17550. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 32 per input module and 16 per output module.

C. Analog input circuits shall be isolated, minimum 16-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTD's. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Lightning/surge protection shall be provided as specified in Section 17560 - Surge Protection Devices. Maximum density for analog I/O modules shall be 8 per module.

D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting mode, or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

E. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

2.05 REMOTE I/O SUBSYSTEMS

A. Remote I/O shall be provided as designated on the Control System Architecture Drawing. Remote I/O shall be either PLC backplane type I/O or field modules as manufactured by the PLC manufacturer. Field modules shall meet the requirements of Subsection 2.04, Input/Output Subsystems. Remote I/O processor or communication modules shall be modular and individually replaceable.

B. Remote I/O shall communicate with the PLC using the PLC manufacturer's standard protocol or an open standard network such as DeviceNet, Ethernet IP, ProfiNet, Foundation Fieldbus, Modbus TCP/IP, or equal.

2.06 INPUT/OUTPUT CIRCUIT ARRANGEMENT

A. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one loop or piece of equipment.

2.07 PROGRAMMING SOFTWARE

A. The PLC programming and configuration software shall be the manufacturer's latest, full-featured version, Windows-based, and shall be fully compliant with IEC 61131-3 standards. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. PLC programming software shall include documentation on optical media.

B. A minimum of one copy of the PLC programming software shall be purchased by the instrumentation subcontractor and registered to the Owner.

C. All configuration and programming software necessary to allow notebook computers to perform PLC configuration and programming shall be provided.

D. If available, the configuration and programming software shall support communication over the network specified in Section 17180 – Process Control System Networks to implement its functions remotely from an operator workstation.

PART 3 - EXECUTION

3.01 REQUIREMENTS

A. PLC programming shall be furnished to perform all functions described in Section 17950 – Functional Control Descriptions, including global functions. In addition, PLCs shall be programmed to provide additional functions described in other sections of this Division.

B. PLC programming shall make use of the various IEC languages as appropriate to the specific task, and shall be performed in a modular style making extensive use of program blocks (subroutines) and program variables to be passed to the program blocks for specific equipment. It is the intent of this requirement to allow for enhanced readability and ease of modification of the program code through the elimination of multiple instances of repeated code for the same function in a "hard-coded" style.

C. Extensive comments shall be placed in the program code to describe the functions of all elements of the program code. PLC code that does not contain comments shall be rejected.

D. Refer to Section 17000, Part 3 for additional requirements.

- END OF SECTION -

SECTION 17125

OPERATOR INTERFACE TERMINALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all operator interface units, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17100 – Digital System Hardware Configuration

C. Section 17120 – Programmable Logic Controllers

PART 2 -- PRODUCTS

2.01 OPERATOR INTERFACE UNIT – LARGE

A. An Operator Interface Terminal (OIT) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface.

B. The OIT shall be Schneider Electric Magelis 10” display with Vijeo Designer software, no substitutions allowed.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. The OIT shall be configured to display all PLC I/O, setpoints, and parameters. All equipment failures shall be alarmed. PLC I/O values and operator-entered setpoints shall be displayed with associated units and service descriptions. Menus shall be provided to navigate between screens of different equipment items. Displays shall be arranged in a hierarchical structure with displays for specific equipment items grouped together. Additional functionality shall be as specified elsewhere in this Division.

B. All necessary configuration and programming software shall be provided on optical media and turned over to the Owner.

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C. Unless otherwise noted, each OIT shall be mounted between 48 and 60 inches above the floor or work platform.

D. Refer to Section 17000 for additional requirements.

- END OF SECTION -

SECTION 17180

PROCESS CONTROL SYSTEM NETWORKS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation IEEE 802.3 Ethernet local area network(s) for communications among plant devices.

B. Local area network shall be provided with all spare parts, accessories, and appurtenances as herein specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17120 – Programmable Logic Controllers

C. Section 17125 – Operator Interface Terminals

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. The following specific spare parts items shall be provided:

1. A termination tool kit shall be provided containing all required tools and consumables for up to 25 connections of each connection type furnished. Termination kit shall be as manufactured by Black Box, Corning Cable Systems, Optical Cable Corporation, or equal.

2. One spare switch of each type furnished under this Contract.

PART 2 -- PRODUCTS

2.01 LOCAL AREA NETWORK (LAN)

A. An IEEE 802.3 Ethernet local area network shall be used for communications between plant devices.

B. Network wiring shall be unshielded, twisted-pair copper cables for connections within buildings. Fiber optic media shall be used for all inter-device communication links extended outside of a building, unless specifically noted. Cables shall be as specified herein.

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C. The Contractor may provide a network configuration different from that shown in the Contract Drawings with written approval of the Engineer, but the Contractor shall coordinate with all affected trades and pay for all additional charges incurred.

D. The Contractor shall supply all hardware, cables, connectors, and software to implement a network as specified herein and shown on drawings.

2.02 INDUSTRIAL ETHERNET NETWORK SWITCHES

A. Except where specifically allowed on the Control System Architecture Drawing, industrial Ethernet network switches shall be provided for each device connected to the process control system network. The switches shall create switched Ethernet networks that conform to the IEEE 802.3 and 802.3u standards using copper wires or optical fibers in a bus, tree or ring network topology as shown on the Drawings. Ethernet network switches shall be modular, rack mounted, or standard DIN-rail mounted within the PLC cabinet or in an adjacent communication cabinet, as shown on the Drawings.

B. Ethernet network switches shall support ring, bus, tree, or point-to-point network topologies. On-line signal monitoring shall be provided to detect and locate impending faults. Ethernet network switches shall be replaceable on-line without disrupting the network. The Ethernet network switches shall be integrated into the in-plant Ethernet network to form a redundant ring network with self-healing communication recovery. Switches shall support the non-proprietary Media Redundancy Protocol (MRP) and Rapid Spanning Tree Protocol (RSTP) in addition to the switch manufacturer's standard redundant ring network protocol, all of which shall provide self-healing communication recovery.

C. Ethernet network switches shall meet the following minimum performance requirements:

Functions:	Modular managed switch with store and forward switching mode, 10 Mbps Ethernet, or 100 Mbps Fast-Ethernet, or gigabit Ethernet support, multi-address capability, auto-crossing, auto-negotiation, auto-polarity. Port speed and duplex auto-negotiation shall be configurable. Each network switch shall manage up to eight (8) ports possible via integrated media modules specified below.
Management:	Simple Network Management Protocol (SNMP) (v1/v2/v3) and Common Industrial Protocol (CIP) support; IGMP filtering and snooping.
Power Requirements:	Redundant 24 VDC power supply
Operating Temperature:	0° - 60°C
Relative Humidity:	10 - 95%
Network Size:	Up to 50 nodes in ring structure

Port Type & Quantity: (at each PLC location)

- MAs required; minimum of four (4) 10/100Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment
- Two (2) 100/1000Base-FX, multimode fiber optic cables (62.5/125 µm), LC, ST or SC sockets, 0-5000 meters LAN segment

Link Budget: 8 dB @ 1300 nm; 10 dB @ 850 nm

Wavelength: 850 or 1300 nm

D. Acceptable industrial Ethernet network switches shall be as manufactured by Cisco Systems, Hirschmann, Phoenix Contact, Weidmuller, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. The destination of all network data cables (both copper and fiber) leaving an enclosure, patch panel, or building shall be labeled at each end using industry-standard wire markers.

B. Refer to Section 17000, Part 3 of the Specifications for additional requirements.

- END OF SECTION -

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SECTION 17190

UNINTERRUPTIBLE POWER SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

B. One UPS shall be provided for each operator workstation and its peripherals (i.e. printer, network equipment, radio, etc.) provided under this Contract.

C. One UPS shall be provided for each programmable logic controller (PLC) or remote telemetry unit (RTU) and its appurtenant equipment provided under this Contract. However, courtesy receptacles in PLC and RTU cabinets shall not be powered by the UPS.

D. UPS's shall be mounted in or near enclosures containing digital hardware, unless otherwise specified or shown on the Drawings, as follows:

1. UPS's for operator's consoles shall be mounted within the consoles.

2. UPS's for control panels containing PLCs shall be mounted either within the cabinet or in an adjacent cabinet of suitable environmental rating.

3. UPS's for RTUs shall be mounted within the RTU cabinet.

4. Where the UPS is mounted within a dedicated enclosure, that enclosure shall be properly sized for heat dissipation and all other applicable requirements as specified in Section 17500 and its subordinate Sections.

5. Where the UPS is mounted within the PLC or RTU cabinet, it shall not interfere with access to other equipment or wiring within the panel (i.e., it shall not be necessary to move or remove the UPS to remove or service other panel-mounted equipment). For floor-mounted PLC cabinets with bottom wiring access (including those cabinets with legs), the UPS shall be placed on a dedicated shelf within the cabinet.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17100 – Control and Information System Hardware, General

C. Section 17120 – Programmable Logic Controllers

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1.03 SUBMITTALS

A. The Contractor shall submit UPS sizing calculations for all UPS's furnished under this Contract in accordance with Section 17030 - Control and Information System Submittals.

PART 2 -- EQUIPMENT

2.01 UNINTERRUPTIBLE POWER SYSTEMS

A. Each UPS shall consist of a freestanding UPS module and battery modules as required to meet backup run time requirements.

B. UPS's shall be true on-line type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.

C. An automatic bypass switch shall be provided on UPS's of greater than 2 kVA capacity. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.

D. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.

E. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.

F. Each UPS shall meet the following requirements:

1. Input voltage shall be 117 VAC, single phase, 60 Hz.

2. Voltage regulation shall be +/-5 percent for line and load changes.

3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.

4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a

minimum full load backup time of 30 minutes for PLC-based control panels, and 45 minutes for remote telemetry units.

5. A status monitoring and control panel shall be provided and shall include the following:

   a. Status indicating lights for both normal and abnormal conditions.

   b. Individual alarm contacts that shall close upon loss of the AC line, low battery level or operation of the static transfer switch. Contacts shall be wired to the closest discrete input subsystem. Alternatively, an RS-232 or USB port shall provide UPS status to an operator workstation. All required interface software and hardware shall be provided.

   c. Circuit breaker for the AC input.

6. Sound absorbing enclosure.

7. EMI/RF noise filtering.

8. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.

G. UPS systems shall be Model GXT2 as manufactured by Liebert, equivalent by Powerware, MGE UPS Systems, GE Digital Energy, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17000, Part 3 of the Specifications.

- END OF SECTION -

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SECTION 17200

CONTROL AND INFORMATION SYSTEM SOFTWARE REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all control and information system software with all required programming and software appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17920 – Control System Input/Output Schedule

PART 2 -- PRODUCTS

2.01 SOFTWARE REQUIREMENTS

A. The Owner's existing SCADA (Human-Machine Interface or HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract.

B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in other Sections of this Division.

2.02 OVERALL SYSTEM CONFIGURATION

A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel" of the Owner's existing system. Major HMI software scope of work shall include but shall not be limited to the following:

1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.

2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment, and create links to the new screens.

3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.

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4. Modify existing reports to include the additional monitoring points specified under this Contract.

5. Create new real-time and historical trends, and coordinate with the Owner appropriate grouping of the trend charts.

6. Update the system status display to include new hardware provided under this Contract.

B. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Software design, implementation and checkout shall satisfy the requirements specified in the various Sections of Division 17.

- END OF SECTION -

SECTION 17500

ENCLOSURES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

B. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17100 – Control and Information System Hardware, General

C. Section 17510 – Cabinets and Panels

D. Section 17550 – Panel Instruments and Accessories

E. Section 17560 – Surge Protection Devices

F. Section 17600 – Instruments, General

G. Section 17900 – Schedules and Control Descriptions, General

H. Refer to Division 16 for additional requirements for cable, circuit breakers, disconnect switches, etc.

1.03 GENERAL INFORMATION AND DESCRIPTION

A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.

B. Either manufacturer-standard or custom cabinetry may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.

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C. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor shall examine plans and/or field inspect new and existing structures as required to determine installation requirements, and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the spare parts items shall be provided as specified in the individual cabinet and panel specification sections (17510).

PART 2 -- PRODUCTS

2.01 TERMINAL BLOCKS

A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Weidmuller, Wieland, Square D, or equal.

B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.

C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top (NEMA 12 cabinets only).

2. Thermostatically controlled, low noise internal air blowers (initial setpoint 75°F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12

cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure interior temperature alarm shall be displayed on the HMI.

E. Intrusion alarm switches shall be provided on all enclosures containing digital hardware and shall generate an alarm to the nearest PLC when any enclosure door is opened.

F. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.

G. Wiring within cabinets, panels, and consoles shall be installed neatly and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16 of the Specifications, except that the minimum wire size for discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

H. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.

I. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

J. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.

K. All installed spare I/O hardware shall be wired along with live I/O wiring to the field wiring terminal blocks within the cabinet. Where space for spare I/O modules has been provided with the PLC backplane or DIN-rail mounting system, corresponding space for wiring, surge protection, and terminations shall be furnished within the cabinet.

L. A copper ground bus shall be installed in each cabinet, and shall be connected to the building power ground.

M. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 16123 - Building Wire and Cable. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 16123. Where applicable, the wire number shall be the ID number listed in the input/output schedules.

N. Wires shall be color coded as follows:

Equipment Ground - GREEN

120 VAC Power - BLACK
120 VAC Power Neutral - WHITE

120 VAC Control (Internally Powered) - RED
120 VAC Control (Externally Powered) - YELLOW

24 VAC Control - ORANGE

DC Power (+) - RED
DC Power (-) - BLACK
DC Control - BLUE

Analog Signal – BLACK/WHITE or BLACK/RED

O. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

P. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

Q. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power". Letters in the word "WARNING" shall be 0.75 inch high, white.

R. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

3.02 PAINTING/FINISHING

A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 9 for additional requirements.

B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.

C. Panels fabricated from stainless steel shall not be painted.

D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be painted.

3.03 INSTALLATION

A. Refer to Section 17000 for additional requirements.

- END OF SECTION -

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SECTION 17510

CABINETS AND PANELS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the cabinets and panels, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17100 – Control and Information System Hardware, General

C. Section 17500 – Enclosures, General

D. Section 17900 – Schedules and Control Descriptions, General

PART 2 -- PRODUCTS

2.01 CABINETS AND PANELS

A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.

B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.

C. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in storage/feed areas for chlorine or other applicable corrosive chemicals shall be of non-metallic construction, rated NEMA 4X, and fully compatible with the associated chemical.

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D. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

E. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Doors for NEMA 4X cabinets shall be all stainless steel with three-point latches. Door hardware on NEMA 4X cabinets located in chemical storage/feed areas shall be non-corrosive in that environment.

F. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits.

G. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

H. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door. When deployed, the laptop shelf shall not be greater than 48 inches above finished floor. Laptop shelf shall be fitted to door with factory applied weld-studs. Weld discoloration and enclosure penetrations will not be accepted.

I. Unless otherwise noted, panel-mounted control devices (OITs, hand switches, etc.) requiring operator access shall be mounted between 48 and 60 inches above the floor or work platform.

J. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Saginaw Control and Engineering (SCE). The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17550

PANEL INSTRUMENTS AND ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the panel instruments and accessories, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

C. Section 17900 – Schedules and Control Descriptions

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the following specific spare parts items shall be provided:

1. One of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract.

2. Five of each type of interposing relay provided under this Contract.

PART 2 -- PRODUCTS

2.01 ELECTRONIC INDICATORS

A. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where

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required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor service as required and shall have the same NEMA enclosure rating as the associated enclosure. Indicators shall be Red Lion Model IMP or APLCL, or equal.

2.02 SIGNAL CONVERTERS

A. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.

B. General Requirements – Converters shall be of the miniature type, utilizing all solid-state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.

C. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

D. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4-20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

E. Frequency to Current Transducers – Frequency to current transducers shall convert pulse-rate and pulse-duration signals to 4-20 mA, 24 VDC analog signals. Converters shall include field-adjustable input frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5100 as manufactured by AGM, or equivalent by Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

F. Current to Frequency Transducers – Current to frequency transducers shall convert 4-20 mA, 24 VDC analog signals to pulse-rate and pulse-duration signals. Converters shall include field-adjustable output frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5016 as manufactured by AGM, Moore

Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

G. Integrators – Integrators shall be provided as interchangeable plug-in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be ± 0.1% of input span. Integrators shall convert linear analog signals to pulse rate and provide a solid-state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

H. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4-20 mADC, and the set point shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be ±0.1% per degree F. The repeatability shall be ±0.1% of span. The units shall be furnished with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

I. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4-20 mADC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Contractor shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer's standard enclosure for installation in an existing indoor electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

J. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be small format type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall have a flag indicator to show relay status, a pushbutton to allow manual operation of the relay, and an internal pilot light to indicate power to the coil. Relays shall be as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

K. Timing Relays – Timing Relays (TR) shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.

L. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA-classified hazardous areas. Intrinsically safe relays and barriers shall

be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

2.03 TOTALIZERS

A. Totalizing counters shall be provided for flush panel, spring-clip mounting. Face dimensions of the totalizing counters shall be no larger than 1-1/8-inches high by 2-inches wide. Totalizing counters shall contain eight digits. Height of the digits shall not be less than 5/32-inch. Numerals shall be white on a black background. The counter shall be non-resettable and shall be totally compatible for operation on the pulses supplied by the associated instrument or integrator. The totalizing counter shall be capable of a maximum count rate of 25 counts/second.

B. Legend plates shall be provided for each of the totalizing counters with white letters on a black background with legends as specified below.

C. Totalizing counters shall be manufactured by Kessler-Ellis, or equal.

2.04 ACCESSORIES

A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.

B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type. Pilot lights shall be of the proper control voltage, push-to-test LED type with light lens colors as specified below.

Color	Function
Red	Running (Open)
Green	Stopped or Off (Closed)
Amber	Fault
White	Other

C. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.

D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.

E. Alarm horns shall be general-purpose type, panel-mounted, and shall be suitable for indoor or weatherproof service, as required. Power supply shall be either 115 VAC or 24 VDC. Horns shall be capable of producing 100 dB at 10 feet, and shall have adjustable

volume. Horns shall be Vibratone series as manufactured by Federal Signal Corporation, McMaster-Carr equivalent, Edwards Signaling Company equivalent, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

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SECTION 17560

SURGE PROTECTION DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install and place in satisfactory operation the surge protection devices (SPDs) as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17100 – Control and Information System Hardware, General

C. Section 17500 – Enclosures, General

D. Section 17900 – Schedules and Control Descriptions, General

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All surge protectors of each type provided under this Contract shall be furnished by a single manufacturer.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the following specific spare parts items shall be provided:

1. Two (2) of each type of surge protection device provided under this Contract.

PART 2 -- PRODUCTS

2.01 SURGE PROTECTION, GENERAL

A. All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.

B. Manufacturer's Requirements: All surge protection devices shall be manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Phoenix Contact, Edco, Transtector, Weidmuller, or equal.

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C. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.

D. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.

E. Device Locations: As a minimum, provide surge protection devices at the following locations:

1. At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters.

2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.

3. At both ends of all copper-based communication cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.

4. On all external telephone communication lines.

2.02 AC POWER PROTECTION

A. Surge protection device assemblies for connections to AC power supply circuits shall:

1. Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.

2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.

3. Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.

4. Comply with all requirements of UL 1449, latest edition.

5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6. Have the following characteristics:

a. Maximum Continuous Operating Voltage: 150VAC

b. Maximum Operating Current: 20 amps

c. Ambient Temperature Range: -20 degrees C to +65 degrees C

d. Response Time: 5 nanoseconds

2.03 ANALOG SIGNAL CIRCUIT PROTECTION

A. Surge protection device assemblies for analog signal circuits shall:

1. Have four lead devices with DIN Rail mounting.

2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

3. Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.

4. Comply with all requirements of UL 497B.

5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6. Limit line-to-line voltage to 40 volts on 24VDC circuits.

7. Have the following characteristics:

a. Maximum Continuous Operating Voltage: 28VDC

b. Ambient Temperature Range: -20 degrees C to +65 degrees C

c. Response Time (Line-to-Line): 5 ns

2.04 COMMUNICATION CIRCUIT PROTECTION

A. Surge protection devices for copper-based data communication circuits shall:

1. Be designed for the specific data communication media and protocol to be protected (i.e. telephone, serial, parallel, network, data highway, coax, twinaxial, twisted pair, RF, etc.).

2. Provide protection of equipment to within the equipment's surge withstand levels for applicable standard test wave forms of the following standards:

a. IEC 60-1 / DIN VDE 0432 part 2

b. CCITT K17 / DIN VDE 0845 part 2

c. IEEE C62.31

3. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

4. Provide automatic recovery.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17600

INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test and place in operation process instrumentation as scheduled herein, as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract, except where noted otherwise.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 –Control and Information System Scope and General Requirements

B. Section 17698 – Instrumentation and Control System Accessories

C. Instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

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B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Floating outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -15 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent,

except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The Contractor shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square 1/2-inch thick aluminum base plate unless shown adjacent to a wall or otherwise noted. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The Contractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation tests, inspection, and calibration requirements specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

2. The Contractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. The Contractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy’s as set forth by the National Institute for Standards and Technology (NIST).

3. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the Contractor shall perform a loop check where applicable. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

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SECTION 17650

PRESSURE GAUGES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

C. Section 17698 – Instrumentation Accessories

PART 2 -- PRODUCTS

2.01 PRESSURE GAUGES

A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".

B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed the approximately 75% of the full-scale range.

C. Features

1. Mounting: ½" NPT, lower stem mount type
2. Accuracy: 0.5% full scale
3. Case: Solid front, black phenolic material
4. Dial: White background and black letters
5. Glass: Shatterproof
6. Blow-out protection: Back
7. Pressure element: stainless steel bourdon tube
8. Movement: Stainless steel, Teflon coated pinion gear and segment
9. Gaskets: Buna-N

D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid shall be silicone unless oxidizing agents such as sodium hypochlorite are present,

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where halocarbon shall be used.

E. Gauge size shall be 2" for line sizes up to 3" and 4½" for line sizes of 4" or greater.

F. Diaphragm seals and isolating ring seals shall be furnished in accordance with the requirements specified under Section 17698 - Instrumentation and Control System Accessories.

G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A ½" isolation stainless steel ball valve shall be provided for each gauge assembly.

H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3.

- END OF SECTION -

SECTION 17670

LEVEL SWITCHES (VAULT FLOOD TYPE)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the float level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Unpowered Instruments, General

PART 2 -- PRODUCTS

2.01 LEVEL SWITCHES (VAULT FLOOD TYPE)

A. The float switch and piping shall be submersible. The switch shall have a hermetically sealed reed switch located inside the stem. The junction box shall be Nema 4X. All construction shall be of PVC, PBT and Buna N for corrosion resistance. Reed switches shall be selectable normally open or normally closed, 0.5A-115V AC capacity. Float switches shall be Model FS 202 as manufactured by Contegra, no substitutions allowed.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3 of the specifications.

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SECTION 17698

INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.

B. Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This Specification shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

C. Section 16902 – Electric Controls and Relays

1.03 SUBMITTALS

A. Per Section 17030, Control and Information System Submittals

B. Impulse piping layout and routing drawings

C. Instrument assembly drawings.

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PART 2 – PRODUCTS

2.01 PROCESS TUBING

A. Process, impulse, or capillary tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with 37 degrees Type 316 stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.

B. Piping for closely coupling instruments to process seals shall be standard stainless steel NPT threaded piping or NPT tapped mounting blocks.

C. A nickel-based lubricant shall be used on threaded stainless steel piping connections to prevent galling.

2.02 POWER, CONTROL, AND SIGNAL CABLES

A. Power, control and signal wiring shall be provided under Division 16 of the Specifications, unless otherwise indicated.

2.03 ISOLATING RING SEALS

A. For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).

1. Full Line Size Isolating Ring Seals

a. Where indicated, the sensor body shall be full line size wafer design.

b. Full line size isolating ring seals shall have 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. Gauge or readout shall be oriented for viewing.

c. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Manufacturer shall furnish seals with a quick-disconnect-type fitting for field disassembly and reassembly, however, seal and instruments shall be factory assembled prior to arriving at the job site

d. Isolating ring seals shall be RED Valve Series 40, Ronningen Petter Iso Ring, Moyno RKL Series W, Onyx Isolator Ring, or equal.

2. Tapped Isolating Ring Seals

a. Where indicated, pressure shall be sensed via a minimum 1-1/2" diameter spool type isolating ring seal mounted on a 1-1/2" pipe nipple at 90 degrees from the process piping.

b. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The factory assembled and filled pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally.

c. Tapped isolating ring seals for solids service shall be Red Valve Series 42/742, Ronningen Petter Iso Spool, Onyx Isolator Ring, or equal.

2.04 FILLING MEDIUM:

A. The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10 degrees F to +150 degrees F.

B. Filling medium shall be silicone unless oxidizing agents, such as sodium hypochlorite, are present, then halocarbon shall be used.

2.05 TAMPER EVIDENT PAINT

A. Piping and screwed/bolted connections of instrumentation containing the filling medium shall be marked with a small continuous tick mark of tamper evident paint over each piping/instrument joint. Tamper evident paint shall be applied prior to instrument assemblies arriving on the job site. Disturbance of the joint shall break the paint.

B. Instrument assemblies with broken paint or missing paint shall not be accepted and shall be repaired or replaced at no additional cost to Owner. Paint shall be Dykem Cross-Check or equal.

2.06 ISOLATION VALVES

A. Isolation valves shall be 1/2 inch diameter ball valves, unless otherwise indicated, with a Type 316 stainless steel body, Type 316 stainless steel ball. Where 316 stainless steel is not compatible with the process fluid, materials of construction shall be suitable for the associated process fluid (e.g., PVC for chemical service).

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Refer to Sections 17600, Part 3 of the Specifications.

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SECTION 17701

MAGNETIC FLOW METERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one spare signal converter.

PART 2 -- PRODUCTS

2.01 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a 316 stainless steel or carbon steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, hard rubber, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes.

D. Grounding rings shall be provided for both ends of all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

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F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C. Meter and transmitter housings shall meet NEMA 4X/IP66 requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Where the flow tube is subject to submergence through installation in a meter vault or similar location, the flow tube assembly shall be rated NEMA 6P/IP68 and electronics shall be factory sealed against moisture intrusion. The use of field kits for modifying NEMA 4/4X/IP66 flow tubes to submergence duty shall not be acceptable. The associated transmitter shall be located in an area not subject to submergence.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. The remote configuration device shall be as specified under Section 17700. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.30% of rate over the flow velocity range of 1.0 to 10.0 m/s (3.0 to 33 ft/sec) and 0.5% between 0.1 m/s and 1.0 m/s (1-3 ft/s). Repeatability shall be ± 0.1% of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°C. Power supply shall be 115 VAC, 60 Hz.

M. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer.

Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

N. Magnetic flow meter systems shall be Model 8750W with optional high accuracy as manufactured by Rosemount, or equivalent by ABB, Endress + Hauser, Foxboro, Krohne, Siemens, Toshiba or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

B. Refer to Section 17600, Part 3, for further requirements.

- END OF SECTION -

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SECTION 17740

ULTRASONIC LIQUID LEVEL MEASUREMENT SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the ultrasonic liquid level measurement systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one hand-held programmer under this Contract to calibrate and configure the level controllers specified herein. The programmer shall be furnished complete with battery plus one spare battery, carrying case and accessories. Programmer shall be furnished by the level instrument manufacturer, and shall be fully matched to the instrument furnished.

PART 2 -- PRODUCTS

2.01 ULTRASONIC LEVEL CONTROLLERS

A. Each ultrasonic level monitoring system shall include one ultrasonic level sensor and an "intelligent" transmitter (controller). The ultrasonic level monitoring system shall be required to monitor the level of process liquids or solids as shown on the Drawings and/or as specified herein. Location of the sensor and transmitters shall be as shown on the Drawings and/or as specified.

B. For outdoor installation, the use of approved watertight conduit hub/glands shall be required. Tank mounting applications shall include mounting flange adapter supplied by the manufacturer, which is compatible with the process media and the tank flange connection. Channel or wall mounting applications shall include mounting bracket supplied by the manufacturer and constructed of 316 stainless steel material. Sensor mounting thread shall be 1" NPT.

C. The level sensor shall be unaffected by moisture droplets on the transducer face and operate on the ultrasonic echo ranging principle. The sensor shall also be fully submersible and resistant to corrosive materials. Sensor accuracy shall be a minimum

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of 0.25 percent of level measurement range, and include integral temperature compensation with an accuracy of 0.09% of range. Resolution shall be at least 0.1 percent of full range or 0.08 inches, whichever is greater.

D. The transmitter shall be programmable by using a hand-held programmer. Display shall be LCD with backlighting, shall have the capability to display a minimum of 4 characters at one time, and shall be shielded from direct sunlight. The units shall have as a minimum, the required number of programmable set points to perform the functions specified. Each set point shall operate a set of contacts rated at 5 amps, 250 VAC, non-inductive.

E. The transmitter shall compensate for changes in temperature and air density. The controller shall be capable of performing the following functions: level monitor, both linear and nonlinear level to flow relationships, volumetric, open channel flow monitoring, differential control, and control of up to 6 pumps, alarms, monitor pump runtime and pump sequencing. Output level signal shall be linear, isolated 4-20 mA DC. Power requirement for the transmitter shall be 120 VAC, 60 Hz. The units shall have a NEMA 4X stainless steel or nonmetallic enclosure.

F. Ultrasonic level measurement system shall be the HydroRanger 200 HMI/Echomax Series Transducers by Siemens/Milltronics, no substitutions allowed.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Where level transducers may become submerged, provide a manufacturer-supplied submergence hood.

B. Where ultrasonic level systems are used on solids measurement applications, provide a swiveling aiming device to allow easy adjustment of beam direction.

C. For open channel flow applications where the transducer is subject to direct sunlight, use an externally mounted temperature compensator mounted out of direct sunlight.

D. Refer to Section 17600, Part 3 of the specifications for additional requirements.

- END OF SECTION -

SECTION 17749

SUBMERSIBLE LEVEL (PRESSURE) SENSORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the submersible level (pressure) sensors, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Control and Information System Scope and General Requirements

B. Section 17700 - Powered Instruments, General

PART 2 -- PRODUCTS

2.01 SUBMERSIBLE LEVEL (PRESSURE) SENSORS

A. Submersible level (pressure) sensors shall consist of a pressure-sensing probe assembly with a depth cable molded directly to the probe body. Sensing probe housing shall be fabricated of titanium or 316 stainless steel. The depth support cable shall be polyurethane and shall contain a Kevlar strength member, a vent tube, and conductors for electrical power and signal.

B. The sensor shall contain an encapsulated pressure sensing element which is electrically and physically isolated from the media via a ceramic or titanium isolation diaphragm. The pressure sensing connection shall be protected from damage by a removable acetal nose cone or equivalent guard.

C. Each submersible level transducer shall be provided with a NEMA 4X termination/junction box and aneroid bellows to prevent moisture from entering the vent tube.

D. Sensor specifications shall be as follows:

1.	Sensor Rating:	NEMA 6 (IP68), loop-powered
2.	Output Signal:	4-20 mA, 2-wire design
3.	Accuracy:	± 0.25%, F.S. (full scale)
4.	Long Term Stability:	± 0.1% F.S./year
5.	Zero Offset and Span Setting:	± 0.25% F.S., max.
6.	Operating Temperature:	-20 to +60 degrees C
7.	Compensated Temperature:	-2 to +30 degrees C

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8. Overpressure Limits: At least 2x full scale range
9. Cable Length: As required

E. Submersible level (pressure) sensors shall be WaterPilot Model FMX 167 by Endress & Hauser, no substitutions allowed.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17900

SCHEDULES AND CONTROL DESCRIPTIONS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all hardware and software required to provide the Control And Information System as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17910 – Instrument Schedule

B. Section 17920 – Control System Input/Output Schedule

PART 2 -- CONVENTIONS

1.01 PLANT NUMBERING SYSTEM

A. The plant equipment numbering system is based on a 2-digit code preceded by an equipment identification prefix and followed by a parallel designation suffix. The numbering system is broken down as follows:

```
XXX  XXX
|     |
|     |     Parallel Designation
|     └────Suffix (2)
|
|           Individual Equipment
└──────────Item Number (1)
```

1. Prefix letters are added as required to label a piece of equipment or describe instrumentation/control signal types. Instrumentation prefixes shall use the convention shown in the following table.

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INSTRUMENT PREFIX LETTERS					
FIRST LETTER			SUCCEEDING LETTERS		
LETTER	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM OR PLC/DCS DISCRETE ALARM INPUT		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	CONDUCTIVITY (ELECTRICAL)			CONTROL OR PLC/DCS ANALOG OUTPUT	
D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		PRIMARY ELEMENT		
F	FLOW	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS OR VIEWING DEVICE		
H	HAND (MANUALLY INITIATED)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE OR PLC/DCS ANALOG INPUT		
J	POWER	SCAN			
K	TIME OR TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOISTURE OR HUMIDITY	MOMENTARY			MIDDLE OR INTERMEDIATE
N	USER'S CHOICE		NOTIFY OR PLC/DCS DISCRETE STATUS INPUT	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE (RESTRICTION)		
P	PRESSURE OR VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE OR TOTALIZE	INTEGRATE OR TOTALIZE		
R	RADIATION		RECORD OR PRINT		
S	SPEED OR FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION OR MECHANICAL ANALYSIS			VALVE, DAMPER OR LOUVER	
W	WEIGHT OR FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED OR PLC/DCS DISCRETE OUTPUT	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, OR CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVE, ACTUATOR OR UNCLASSIFIED FINAL CONTROL ELEMENT	

2. The parallel designation suffix shall be used to differentiate items of similar function and service that would otherwise have the same number. The suffix shall use the following conventions depending on application:

   a. {none}
   b. A, B, C,...
   c. A1, A2, A3,...B1, B2, B3,...C1, C2, C3,...

PART 3 – EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17910

INSTRUMENT SCHEDULE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17900 – Schedules and Control Descriptions

B. Section 17920 – Control System Input/Output Schedule

C. Section 17950 – Functional Control Descriptions

PART 2 -- INSTRUMENT SCHEDULE

Pressure Gauges - Section 17650			
Tag Number	**Service Description**	**State/Span**	**Remarks**
PI-045	Penn Ave WWPS Discharge	0-60 PSI	Provide fully assembled with associated tapped isolating ring seal.
PI-045	Conway WWPS Discharge	0-60 PSI	Provide fully assembled with associated tapped isolating ring seal.
Level Switches (Suspended Float) - Section 17670			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LSH-055	Penn Ave WWPS Meter Vault	Set height in field	Provide Intrinsic Safety, Provide Junction Box
LSH-055	Conway WWPS Meter Vault	Set height in field	Provide Intrinsic Safety, Provide Junction Box
Tapped Isolating Ring Seals - Section 17698			
Tag Number	**Service Description**	**State/Span**	**Remarks**
PE-045	Penn Ave WWPS Discharge	1 ½”	
PE-045	Conway WWPS Discharge	1 ½”	
Magnetic Flow Meters - Section 17701			
Tag Number	**Service Description**	**State/Span**	**Remarks**
FE-050	Penn Ave WWPS Flow Tube	6”	
FIT-050	Penn Ave WWPS Flow Transmitter	300-600 gpm	Provide Surge Protection, Remote Mount Transmitter

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FE-050	Conway WWPS Flow Tube	6”	
FIT-050	Conway WWPS Flow Transmitter	400-870 gpm	Provide Surge Protection, Remote Mount transmitter
Ultrasonic Level Transmitters - Section 17740			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LE/LIT-001	Penn Ave WWPS Wet Well	0-30 ft	Provide Surge Protection, Provide Intrinsic Safety, Remote Mount Transmitter
LE/LIT-001	Conway WWPS Wet Well	0-20 ft	Provide Surge Protection, Provide Intrinsic Safety, Remote Mount Transmitter
Submersible Level (Pressure) Sensors - Section 17749			
Tag Number	**Service Description**	**State/Span**	**Remarks**
PE/LT-002	Penn Ave WWPS Wet Well	0-30 ft	Provide Surge Protection, Provide Intrinsic Safety
PE/LT-002	Conway WWPS Wet Well	0-20 ft	Provide Surge Protection, Provide Intrinsic Safety

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17920

CONTROL SYSTEM INPUT/OUTPUT SCHEDULE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all control system inputs and outputs as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17900 – Schedules and Control Descriptions

B. Section 17910 – Instrument Schedule

PART 2 -- CONTROL SYSTEM INPUT / OUTPUT SCHEDULE

PENN AVE WWPS (PLC-PENN AVE)				
Tag Number	Service Description	State/Span	Type	Remarks
LI-001	Wet Well	Level	AI	
LI-002	Wet Well (alarms)	Level	AI	
YL-010	Pump No. 1	In Auto	DI	
YLR-010	Pump No. 1	Running	DI	
YA-010A	Pump No. 1	VFD Fail	DI	
TAH-010	Pump No. 1	High Motor Temp	DI	
MAH-010	Pump No. 1	Seal Fail	DI	
HS-010A	Pump No. 1	Start/Stop	DI	
SC-010	Pump No. 1	Speed Control	AO	
SI-010	Pump No. 1	Speed Feedback	AI	
YA-010B	Pump No. 1	Bypass Fail	DI	
YL-010B	Pump No. 1	In Local Bypass	DI	
HS-010B	Pump No. 1	In Remote Bypass	DO	
YL-020	Pump No. 2	In Auto	DI	
YLR-020	Pump No. 2	Running	DI	
YA-020A	Pump No. 2	VFD Fail	DI	
TAH-020	Pump No. 2	High Motor Temp	DI	
MAH-020	Pump No. 2	Seal Fail	DI	
HS-020A	Pump No. 2	Start/Stop	DI	
SC-020	Pump No. 2	Speed Control	AO	
SI-020	Pump No. 2	Speed Feedback	AI	
YA-020B	Pump No. 2	Bypass Fail	DI	
YL-020B	Pump No. 2	In Local Bypass	DI	
HS-020B	Pump No. 2	In Remote Bypass	DO	
YL-030	Pump No. 3	In Auto	DI	
YLR-030	Pump No. 3	Running	DI	

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PENN AVE WWPS (PLC-PENN AVE)				
Tag Number	Service Description	State/Span	Type	Remarks
YA-030	Pump No. 3	Fail	DI	
HS-030	Pump No. 3	Start/Stop	DO	
FI-050	Pump Station Discharge	Flow	AI	
LAH-055	Meter Vault	High Level Alarm	DI	
YA-200	PLC/RTU Panel Intrusion	Alarm	DI	
YLR-101	Generator	Running	DI	
YA-101	Generator	Low Fuel	DI	
YL-102A	Automatic Transfer Switch (ATS)	On Utility	DI	
YL-102B	Automatic Transfer Switch (ATS)	On Backup	DI	
LAL-103	Oil Reservoir Control Panel	Low Level Alarm	DI	

CONWAY WWPS (PLC-CONWAY)				
Tag Number	Service Description	State/Span	Type	Remarks
LI-001	Wet Well	Level	AI	
LI-002	Wet Well (alarms)	Level	AI	
YL-010	Pump No. 1	In Auto	DI	
YLR-010	Pump No. 1	Running	DI	
YA-010A	Pump No. 1	VFD Fail	DI	
TAH-010	Pump No. 1	High Motor Temp	DI	
MAH-010	Pump No. 1	Seal Fail	DI	
HS-010A	Pump No. 1	Start/Stop	DI	
SC-010	Pump No. 1	Speed Control	AO	
SI-010	Pump No. 1	Speed Feedback	AI	
YA-010B	Pump No. 1	Bypass Fail	DI	
YL-010B	Pump No. 1	In Local Bypass	DI	
HS-010B	Pump No. 1	In Remote Bypass	DO	
YL-020	Pump No. 2	In Auto	DI	
YLR-020	Pump No. 2	Running	DI	
YA-020A	Pump No. 2	VFD Fail	DI	
TAH-020	Pump No. 2	High Motor Temp	DI	
MAH-020	Pump No. 2	Seal Fail	DI	
HS-020A	Pump No. 2	Start/Stop	DI	
SC-020	Pump No. 2	Speed Control	AO	
SI-020	Pump No. 2	Speed Feedback	AI	
YA-020B	Pump No. 2	Bypass Fail	DI	
YL-020B	Pump No. 2	In Local Bypass	DI	
HS-020B	Pump No. 2	In Remote Bypass	DO	
YL-030	Pump No. 3	In Auto	DI	
YLR-030	Pump No. 3	Running	DI	
YA-030	Pump No. 3	Fail	DI	
HS-030	Pump No. 3	Start/Stop	DO	
FI-050	Pump Station Discharge	Flow	AI	
LAH-055	Meter Vault	High Level Alarm	DI	
YA-200	PLC/RTU Panel Intrusion	Alarm	DI	
YLR-101	Generator	Running	DI	

CONWAY WWPS (PLC-CONWAY)				
Tag Number	Service Description	State/Span	Type	Remarks
YA-101	Generator	Low Fuel	DI	
YL-102A	Automatic Transfer Switch (ATS)	On Utility	DI	
YL-102B	Automatic Transfer Switch (ATS)	On Backup	DI	
LAL-103	Oil Reservoir Control Panel	Low Level Alarm	DI	

Notes:

1. Input/Output types are as follows:

   DI - Discrete Input
   DO - Discrete Output
   AI - Analog Input
   AO - Analog Output

PART 3 -- EXECUTION

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SECTION 17950

FUNCTIONAL CONTROL DESCRIPTIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment as herein specified and as shown on the Drawings. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING COMPLETE FUNCTIONING SYSTEMS AS DESCRIBED HEREIN.

B. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.

C. THE FUNCTIONAL DESCRIPTIONS CONTAIN REQUIREMENTS FOR FURNISHING AND INSTALLING LABOR AND MATERIALS THAT MAY NOT APPEAR ELSEWHERE IN THE CONTRACT DOCUMENTS.

D. All equipment and services required in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Contractor through individual equipment suppliers.

E. Unless specifically stated otherwise, all interconnected wiring between all instruments, panels, controls, and other devices listed in the functional descriptions as required to provide all functions specified herein shall be furnished by the Electrical Contractor under Division 16. The Electrical Contractor shall provide all cable and conduit required to carry all signals listed in the process input/output schedules. Special cables that are required for interconnection between sensors or probes and transmitters or signal conditioners shall be furnished with the instrumentation devices by the equipment supplier.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01520 – Maintenance of Utility Operations During Construction

B. Section 17900 – Schedules and Control Descriptions, General

C. Section 17910 – Instrument Schedule

D. Section 17920 – Control System Input/Output Schedule

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PART 2 -- FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL

2.01 DEFINITIONS

A. RUNNING status signals shall be from auxiliary contacts provided with the motor control equipment (i.e., starter, VFD, SCR, etc.).

B. AUTO status signals shall be defined as HAND-OFF-AUTO switch in the AUTO position or process control system in AUTO (versus MANUAL).

C. FAIL status signals shall be defined as motor overload and/or any other shut down mode such as overtorque, overtemperature, low oil pressure, high vibration, etc.

D. READY status signal shall be defined as all conditions, including equipment control power, satisfied to permit remote control of the equipment.

E. HMI (Human Machine Interface) refers to operator workstation located at Opequon Water Reclamation Facility.

F. OIT (Operator Interface Terminal) refers to the touchscreen interface panel mounted on the main control panel, located at the pump station.

2.02 CONVENTIONS

A. Operator workstation graphic display symbols and indicator lights on all MCC's, control panels, starter enclosures, etc. shall conform to the following color convention:

Condition	Color
Running/On/Open	Red
Auto/Ready	White
Stopped/Off/Closed	Green
Fail/Alarm	Amber
Generic Status	Blue or White

2.03 PROCESS CONTROL

A. Where setpoints, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable and, based on actual operating conditions, the instrumentation subcontractor shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.

B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:

1. For alarms and control actions derived from analog input signals, use adjustable time delays and deadbands.

2. For alarms and control actions derived from discrete input signals, use adjustable time delays.

3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for deadbands shall be 5% of span (range 0-100%).

4. Equipment that is started or stopped manually by the operator shall start or stop immediately, with no time delay.

C. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the Integral and Derivative functions to zero. All setpoints, sequence times, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the operator workstations.

D. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in PLC control logic. Unless otherwise specified, all PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power.

E. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero.

F. Equipment failure shall be generated through the PLC for any drive, motor, etc. for which a command has been issued, but for which the PLC is not receiving a confirming status signal (e.g., start command with no run feedback). The failure shall be logged.

G. Instrument failure shall be generated via the operator work stations for any instrument which is generating a signal which is less than 4 mA or greater than 20 mA.

H. A control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in AUTO. If equipment within an equipment chain is required to be running for program operation and it is running in HAND or MANUAL, then the program shall run and control the other equipment that is in AUTO.

I. All PLC wait states (internal time delays, etc.) after an operator action shall be displayed on the operator workstation.

PART 3 -- FUNCTIONAL CONTROL DESCRIPTIONS – PENNSYLVANIA AVENUE WWPS AND CONWAY WWPS (THE FOLLOWING DESCRIPTIONS ARE APPLICABLE TO EACH STATION)

1.01 PROCESS OVERVIEW

A. Two (2) wastewater pumps shall be provided under Division 11. Variable speed drives and bypass motor starters shall be provided for the pumps under Division 16. The pumps shall transfer wastewater from the lift station wet well to the treatment plant.

1. The pumps shall be operated in a lead/lag arrangement with the lag pump operating only during emergency high flow conditions. If the lag pump is called to run, an alarm shall be provided at the OIT and HMI.

B. One (1) conditioning pump shall be provided under Division 11. The conditioning pump shall run to provide mixing of wet well prior to the wastewater pumps being called to run.

1.02 CONTROL EQUIPMENT

A. One (1) Main Control Panel shall be provided under Division 17 for PLC based control of the pump station. The control panel shall meet all requirements in Division 17.

B. One (1) ultrasonic level measurement system shall be provided as specified in Section 17740.

C. One (1) submersible level (pressure) sensor shall be provided as specified in Section 17749.

D. One (1) magnetic flow meter shall be provided as specified in Section 17701.

1.03 CONTROL OPERATIONS

A. General / Level Measurement

1. The operator shall enter a wet well operational level setpoint at the OUI (Operator Interface Unit), located at the pump station. The PLC shall calculate pump start and stop levels that are initially set at 1.0 ft above and 1.0 ft below the level setpoint, respectively. The pumps shall operate in a Lead/Lag sequence to maintain the operational level setpoint. Initial level setpoints for each pump station are as follows:

Pump Station	**Level Setpoint Elevation**
Conway WWPS	665.0 ft
Penn Ave WWPS	707.0 ft

2. When the H-O-A switch is in the HAND position, the corresponding pump shall be controlled by the local START/STOP pushbutton. Motor speed shall be as set at the VFD via the interface. When the H-O-A switch is in the OFF position, the pump shall not operate under any condition. When the H-O-A switch is in the AUTO position, the corresponding pump shall be controlled (START/STOP) by the PLC and speed shall be controlled by a 4-20 mA signal from the PLC. H-O-A switch and START/STOP pushbutton are common for both VFD or Bypass mode. See Contract Drawings for more detail.

B. Wastewater Pump Start/Stop Control

1. The PLC shall start the lead pump (when no pumps are running) or the next pump in the sequence when all of the following are true:

    a. Conditioning pump runtime has elapsed, and conditioning pump is off. (only applicable to lead pump start)

    b. Wet well level reaches the corresponding pump start setpoint.

    c. All running pumps are operating at maximum speed.

    d. A 20-second time delay has elapsed.

2. The PLC shall stop the next pump in the sequence when all of the following are true:

    a. Wet well level reaches the corresponding pump stop setpoint.

    b. All running pumps are operating at minimum speed.

    c. A 20-second time delay has elapsed.

3. The PLC shall shut down the conditioning pump and call the lead pump to run if the wet well has reached a high water level setpoint (off the ultrasonic level transmitter). When called to run, the pumps will run in normal auto mode as described above. High water level alarm shall be reported back through SCADA, with no reset required.

4. Bumpless transfer shall be provided when a pump's operational mode is changed from either manual to automatic or from automatic to manual.

    a. When a non-operating pump changes modes (e.g. when a pump changes from auto to manual mode), its operational state shall remain unchanged.

    b. When an operating pump changes from auto to manual mode, it shall continue running and there shall be no "blips" in the associated PLC start command.

    c. When an operating pump changes from manual to auto mode, the pump shall continue running until the automatic control strategy stops it. For example if two pumps are operating in a wet well application while one is in automatic mode and the other is in manual mode and the system is in a steady state condition, neither pump shall be stopped if the manually controlled pump's mode is changed to automatic mode.

5. The PLC shall stop all operating pump(s) and shall generate an alarm at the HMI and the OIT upon any of the following conditions:

    a. Low-Low wet well level (LALL-002, off LI-002)

    b. Loss of level measurement signal (off LI-001)

Upon alarm acknowledgement, operations shall have the ability to override pump controls and manually control the pumps locally or remotely. Float switches shall be monitored for wet well level conditions until the ultrasonic level transmitter issue is resolved.

C. Pump Speed Control

1. Pump speed shall be controlled to maintain the operational level setpoint.

2. In the event both pumps are running, they shall operate at the same speed and shall be ramped up and down together. When a new pump is started, the speed of the operating pumps shall be ramped down to minimum speed to match the speed of the starting pump to prevent momentary flow rate spikes ("bumps") in the process. When a pump is shut down, the speed of the operating pumps shall be ramped up to the maximum speed associated with the number of pumps running to prevent momentary flow rate spikes ("bumps") in the process.

3. Pumps shall be provided with speed clamps depending on the number of pumps in operation. These speed clamps shall be adjusted to accommodate field conditions, but shall be initially set according to the following table:

No. Pumps Running	**lead**	**standby**
Max Speed, %	100	100
Min Speed, %	65	65

D. Pump Rotation

1. The operator shall select either manual or automatic pump rotation mode at the OIT or HMI. Pump lead/lag designation shall be continuously displayed on the OIT and HMI.

   a. In manual rotation mode, the current lead pump shall become the last available pump and the balance of the available pumps shall be incremented within the sequence (i.e., the sequence shall be reordered such that lag1 pump becomes the new lead pump, lag2 pump becomes the new lag1 pump, etc.).

   b. In automatic rotation mode, the sequence shall be reordered based on current run time values as described above. The pump with the lowest run time shall become the lead pump.

   c. If a currently running pump is still required to be running after the sequence is reordered, the pump shall run continuously through the process and shall not be called to stop during the reordering of the rotation sequence. For example, if two pumps are currently running when the sequence is reordered and the current lead pump becomes the new lag, that pump shall not be stopped and started in rapid succession.

d. If the process has not caused the pumps to rotate in either mode, the pumps shall rotate either every 24 hours (operator adjustable setpoint 1-48 hours or never) or at an operator-entered time of day.

2. If a pump that is called to start fails to start after a 10-second time delay or if a pump in operation fails, the standby pump shall be immediately started. The failed pump shall be removed from the rotation sequence and alarm shall be send to the HMI and the OIT.

3. Pumps that are out of service, in manual control, or failed shall not be considered for automatic control and shall not be included in the alternation sequence.

E. Conditioning Pump Operation

1. When the H-O-A switch is in the HAND position, the pump shall be called to run. When the H-O-A switch is in the OFF position, the pump shall not operate under any condition. If the H-O-A switch is in the AUTO position, the corresponding pump shall be controlled (START/STOP) by the PLC.

2. In AUTO mode, the conditioning pump shall be called to run for a set time period (adjustable, initial setting 2 minutes) when no wastewater pumps are operating and when the water level reaches the wastewater pump start level setpoint elevation, as shown above. When the pump run time period has elapsed, the conditioning pump shall shutdown and not be enabled to run again until after all wastewater pumps have shutdown.

F. Wastewater Pump Operation – Bypass Operation

1. When the H-O-A switch is in the HAND position, the corresponding pump shall be controlled by the local START/STOP pushbutton. When the H-O-A switch is in the OFF position, the pump shall not operate under any condition. When the H-O-A switch is in the AUTO position, the corresponding pump shall be controlled from the OIT or HMI. H-O-A switch and START/STOP pushbutton are common for both VFD or Bypass mode. See Contract Drawings for more detail.

G. SCADA Monitoring and Control

1. Monitoring and control points described above and shown in Contract Drawings shall be provided at both the OIT and HMI (SCADA).

- END OF SECTION –

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