<table>
<thead>
<tr>
<th>SPECIFICATION SECTION</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION 1</td>
<td>Scope of Work and Procedures</td>
<td></td>
</tr>
<tr>
<td>01502</td>
<td>Pump Station Flow Control</td>
<td>1-3</td>
</tr>
<tr>
<td>16000</td>
<td>Materials and Equipment</td>
<td>1-4</td>
</tr>
<tr>
<td>01650</td>
<td>Starting of System</td>
<td>1-6</td>
</tr>
<tr>
<td>SECTION 2</td>
<td>Site Construction</td>
<td></td>
</tr>
<tr>
<td>02060</td>
<td>Building and Structure Demolition</td>
<td>1-4</td>
</tr>
<tr>
<td>02300</td>
<td>Earthwork</td>
<td>1-11</td>
</tr>
<tr>
<td>02495</td>
<td>Construction Vibration Monitoring</td>
<td>1-5</td>
</tr>
<tr>
<td>SECTION 3</td>
<td>Concrete</td>
<td></td>
</tr>
<tr>
<td>03300</td>
<td>Cast-in-Place Concrete</td>
<td>1-26</td>
</tr>
<tr>
<td>03400</td>
<td>Precast Concrete Valve Vaults</td>
<td>1-10</td>
</tr>
<tr>
<td>03930</td>
<td>Concrete Rehabilitation</td>
<td>1-8</td>
</tr>
<tr>
<td>03931</td>
<td>Concrete Protective Coatings</td>
<td>1-8</td>
</tr>
<tr>
<td>SECTION 4</td>
<td>Masonry</td>
<td></td>
</tr>
<tr>
<td>04200</td>
<td>Cavity Wall Masonry System</td>
<td>1-10</td>
</tr>
<tr>
<td>SECTION 5</td>
<td>Metals</td>
<td></td>
</tr>
<tr>
<td>05500</td>
<td>Miscellaneous Metal Items</td>
<td>1-7</td>
</tr>
<tr>
<td>05501</td>
<td>Anchor Bolts and Anchors</td>
<td>1-3</td>
</tr>
<tr>
<td>05510</td>
<td>Metal Stairs</td>
<td>1-4</td>
</tr>
<tr>
<td>05520</td>
<td>Handrails and Railings</td>
<td>1-5</td>
</tr>
<tr>
<td>05715</td>
<td>Fabricated Spiral Stairs</td>
<td>1-4</td>
</tr>
<tr>
<td>SECTION 6</td>
<td>Woods and Plastics</td>
<td></td>
</tr>
<tr>
<td>06200</td>
<td>Rough and Finish Carpentry</td>
<td>1-8</td>
</tr>
<tr>
<td>SECTION 7</td>
<td>Thermal and Moisture Protection</td>
<td></td>
</tr>
<tr>
<td>07311</td>
<td>Asphalt Shingles</td>
<td>1-5</td>
</tr>
<tr>
<td>07620</td>
<td>Sheet Metal Flashing and Trim</td>
<td>1-7</td>
</tr>
<tr>
<td>07900</td>
<td>Joint Sealants</td>
<td>1-5</td>
</tr>
<tr>
<td>SECTION 8</td>
<td>Doors and Windows</td>
<td></td>
</tr>
<tr>
<td>08100</td>
<td>Steel Doors, Frames, and Hardware</td>
<td>1-4</td>
</tr>
<tr>
<td>08310</td>
<td>Hatches</td>
<td>1-3</td>
</tr>
<tr>
<td>SECTION 9</td>
<td>Finishes</td>
<td></td>
</tr>
<tr>
<td>09900</td>
<td>Painting</td>
<td>1-10</td>
</tr>
<tr>
<td>SECTION</td>
<td>TITLE</td>
<td>PAGE</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>SECTION 11</td>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>11307</td>
<td>Factory Assembled Vacuum Stations</td>
<td>1-14</td>
</tr>
<tr>
<td>11308</td>
<td>Factory Assembled Vacuum Pump Station Control Panel</td>
<td>1-10</td>
</tr>
<tr>
<td>SECTION 13</td>
<td>Special Construction</td>
<td></td>
</tr>
<tr>
<td>13329</td>
<td>Sequence of Operation</td>
<td>1-8</td>
</tr>
<tr>
<td>SECTION 14</td>
<td>Conveying Systems</td>
<td></td>
</tr>
<tr>
<td>14630</td>
<td>Trolley and Runway Beam</td>
<td>1-3</td>
</tr>
<tr>
<td>SECTION 15</td>
<td>Mechanical</td>
<td></td>
</tr>
<tr>
<td>15062</td>
<td>Interior Pipe, Fittings, Valves, and Specialties</td>
<td>1-13</td>
</tr>
<tr>
<td>15100</td>
<td>Vertical Extended Shaft Centrifugal Pumping Equipment</td>
<td>1-8</td>
</tr>
<tr>
<td>15150</td>
<td>Non-Clog Submersible Centrifugal Pumps and Drives</td>
<td>1-9</td>
</tr>
<tr>
<td>15160</td>
<td>Diesel-Engine Driven Emergency Pumping System</td>
<td>1-12</td>
</tr>
<tr>
<td>15163</td>
<td>Variable Frequency Drives</td>
<td>1-10</td>
</tr>
<tr>
<td>15170</td>
<td>Level, Pressure, and Intrusion Sensing Systems</td>
<td>1-8</td>
</tr>
<tr>
<td>15492</td>
<td>Fuel Gas Piping</td>
<td>1-9</td>
</tr>
<tr>
<td>15700</td>
<td>Heating and Ventilation Equipment</td>
<td>1-6</td>
</tr>
<tr>
<td>SECTION 16</td>
<td>Electrical</td>
<td></td>
</tr>
<tr>
<td>16010</td>
<td>Electrical General Requirements</td>
<td>1-7</td>
</tr>
<tr>
<td>16050</td>
<td>Basic Electrical Materials and Methods</td>
<td>1-7</td>
</tr>
<tr>
<td>16120</td>
<td>Conductors and Cables</td>
<td>1-4</td>
</tr>
<tr>
<td>16130</td>
<td>Raceways, Boxes, and Fittings</td>
<td>1-7</td>
</tr>
<tr>
<td>16140</td>
<td>Wiring Devices</td>
<td>1-2</td>
</tr>
<tr>
<td>16170</td>
<td>Disconnect Switches</td>
<td>1-2</td>
</tr>
<tr>
<td>16260</td>
<td>Motor Controllers</td>
<td>1-4</td>
</tr>
<tr>
<td>16310</td>
<td>Motor Control Panel</td>
<td>1-7</td>
</tr>
<tr>
<td>16320</td>
<td>Panelboards</td>
<td>1-4</td>
</tr>
<tr>
<td>16330</td>
<td>Transformers</td>
<td>1-2</td>
</tr>
<tr>
<td>16340</td>
<td>Surge Protection Devices</td>
<td>1-4</td>
</tr>
<tr>
<td>16400</td>
<td>Electric Service</td>
<td>1-3</td>
</tr>
<tr>
<td>16430</td>
<td>Enclosed Main Circuit Breaker</td>
<td>1-3</td>
</tr>
<tr>
<td>16450</td>
<td>Electrical Grounding System</td>
<td>1-3</td>
</tr>
<tr>
<td>16500</td>
<td>Lighting</td>
<td>1-5</td>
</tr>
<tr>
<td>16620</td>
<td>Engine Generators</td>
<td>1-20</td>
</tr>
<tr>
<td>16630</td>
<td>Automatic Load Transfer Switch</td>
<td>1-6</td>
</tr>
</tbody>
</table>
Section 01000 – Special Provisions

1. General.

1.1 Summary

A. This section provides special information to the City of Virginia Beach Standard Pump Station Specification attached herein, and hereafter referred to as the “Standard”. The Standard includes information applicable to various types of sanitary pumping stations. Special information shall be listed below as “Replace:”, “Add:” or “Change”. The drawings shall be referenced to determine the applicability of information included in the specification. For example, Section 13329 indicated the sequence of operation for multiple pump and speed station configurations. By examination of the drawings, it may be determined which pump quantity and speed control option is required. Any questions regarding applicability of the specification data shall be brought to the attention of the City prior to bid.

B. These documents refer to the (PROJECT NAME) project and were downloaded from the City of Virginia Beach Public Utilities internet site on (DATE).

1.2 Submittal Requirements

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions. See Section 105.02 of the General Provisions for submittal requirements and Section 01600 – Materials and Equipment.

Section XXXXX – Example

Subsection X.XX.X.X

Replace:  Replace “YYYY” with “ZZZZ”.
Add:  Add “ZZZZ”.
Change:  Change YYYY” to “ZZZZ”.

END OF SECTION
Section 01502 – Pump Station Flow Control

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials, and equipment in the work for furnishing and installing measures for the control of sewage.

B. Related sections

01600 Materials and Equipment

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. The CONTRACTOR shall submit flow control and sewage bypassing arrangement plans to the OWNER for review and approval at least 14 days prior to commencing work on each portion of the system. Flow control includes, but is not limited to, plugging and bypass pumping or hauling as appropriate for the work to be performed. The plans must be specific and complete, and shall include, but not be limited to, the following details:

1) Capacities of equipment.
   (a) Calculations of static lift, friction losses, and flow velocity.
   (b) Pump curves showing design points and operating range.

2) Number and types of pump.
   (a) Two minimum.
   (b) Lead pump to be electric motor powered.
   (c) Lag pump to be diesel engine powered.

3) Road crossing details.

4) Roadway restoration details.

5) Protection against pipe breaks.

6) Sewer plugging methods and bypass time duration.

7) Size, length, material, and method of installation for suction and discharge piping.

8) Method of noise control for each pump and/or generator.

9) Locations of bypass equipment, suction intake and pump discharge.
10) Alarm system with a monitoring and response plan.

11) List of emergency CONTRACTOR contact phone numbers for at least 3 CONTRACTOR personnel in order of importance.

2. **Products. (Not Used)**

3. **Execution.**

3.1 **Flow Control**

A. Bypassed flows must be discharged to the sanitary sewer system, appropriate watertight vehicle or appropriate watertight container.

B. Flows shall be diverted, hauled, or otherwise handled to prevent flows from interfering with the work to be performed on that portion of the system.

C. When pumping/bypassing is required, the CONTRACTOR shall supply the necessary pumps, conduits, engines and other equipment to divert the flow of sewage as appropriate. The CONTRACTOR shall have backup equipment available should the primary system fail. The pumping/bypass system shall be adequate in size to handle the existing peak use flows and additional flows that occurs with rainstorms.

D. The CONTRACTOR shall furnish the labor and supervision to set up, operate, and maintain the pumping/bypass system.

E. The CONTRACTOR shall select pumping/bypass equipment that will not have noise levels above 60 decibels at a distance of 50 feet.

F. The CONTRACTOR shall provide a seven-calendar day notice to the OWNER’S Project Manager prior to any scheduled bypass pumping start up. The CONTRACTOR shall demonstrate 48 hours of successful bypass pumping for the proposed system prior to disabling the pump station. Start-up of any bypass pumping system will only be allowed during regular business hours (8:00 a.m. to 5:00 p.m.) on Mondays through Wednesdays of any given week, excluding Holidays.

G. Operation of any force main valves shall only be performed by the OWNER.

H. The CONTRACTOR will be responsible for installing a pump control float system and high water level alarm float related to its bypass pumping operation, as determined by the OWNER. An automatic call box shall also be installed, which will provide alarm notifications to both the CONTRACTOR and the Virginia Beach Public Utilities Control Center. The alarm notification for the Control Center shall include the address of the bypass pumping operation. This is a requirement whenever bypass pumping lasts longer than one working day. During the 48 hours of bypass pump testing, the call box shall also be tested to ensure notifications are received by all appropriate parties. The OWNER will also install a separate high level back up alarm system to provide notifications through its SCADA system.

I. Once the 48 hours of bypass are successfully completed, the CONTRACTOR will notify the OWNER’S Project Manager who will notify Operations’ personnel for consent before turning off the station power.
J. The CONTRACTOR must call the control center (385-1409) EACH time the station is entered, and EACH time the CONTRACTOR leaves the station. Also, the CONTRACTOR must inform the Control Center EACH time the power to the station is turned off and EACH time the power is turned back on.

3.2 Flow Control Precautions

A. When flow in a sewer line is plugged, blocked, or bypassed, the CONTRACTOR shall take precautions to protect the public health and to protect the sewer lines from damage that might result from sewer surcharging. Further, the CONTRACTOR shall take precautions to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved. The CONTRACTOR shall be responsible for any damage resulting from their flow control operations.

B. When flow in a sewer line is plugged or blocked, the CONTRACTOR shall monitor the conditions upstream of the plug and shall be prepared to immediately start bypass pumping, if needed. No such liquid or solid matter shall be allowed to be discharged, stored or deposited on the ground, swale, road, storm water drainage system or other open environment.

C. The CONTRACTOR shall protect all pumps, conduit and other equipment used for bypass from traffic.

D. Should any liquid or solid matter from the sewer collection system be spilled, discharged, leaked or otherwise deposited to the open environment as a result of the CONTRACTOR’S flow control operations, the CONTRACTOR shall immediately clean up and disinfect the affected area and assume all associated costs. The CONTRACTOR shall immediately notify the OWNER of any spill related to flow control. The CONTRACTOR shall complete a spill report form found in the project Stormwater Pollution Prevention Plan (SWPPP), if applicable, and provide the completed form to the OWNER. The CONTRACTOR shall be responsible for notifying the appropriate regulatory agencies.

E. If the CONTRACTOR does not arrive on-site with sufficient manpower, materials, and equipment to actively respond to an alarm situation or potential sanitary sewer overflow (SSO) within 2-hours from notification and the OWNER has to respond, the cost for this response by the OWNER will be the responsibility of the CONTRACTOR, and the CONTRACTOR will be invoiced for the OWNER’S labor, material, and equipment.

END OF SECTION
Section 01600 – Materials and Equipment

1. General.

1.1 Summary

A. This section addresses the requirements for submittal of shop drawings and the delivery of equipment and materials required for construction of the project.

B. Related Sections

All

1.2 Submittals

A. Refer to the EQUIPMENT AND MATERIAL CHECKLIST in the Appendix of the Project Manual for items requiring Shop Drawing or Material Certification Submittal and Approval, manufacturer’s start-up services, spare parts, and operation and maintenance manuals. Requirements over and above those included in the General Conditions and in this or other Sections of Division 1 shall be as included in the individual Specification Sections.

B. Submittals shall be organized by Specification Section or logical grouping and shall be inclusive of all applicable items. Incomplete submittals or submittals that encompass multiple Specification Sections will be returned without review.

C. The CONTRACTOR shall provide one (1) Portable Document Format (PDF) file for each submittal. The CONTRACTOR shall not mark up any submittal in the color RED. That color is reserved for review comments by the ENGINEER/OWNER. Submittals that are marked in RED by the CONTRACTOR will be returned without review.

D. In the event any submittal requires revisions and must be resubmitted, the CONTRACTOR shall resubmit the entire submittal with revisions. Partial submittals that only contain the revisions will be returned without review.

1.3 Materials and Equipment

A. For the purpose of standardization, equipment of any one type shall be the products of one manufacturer.

B. Do not use secondhand or salvaged materials and equipment whether removed from existing premises or from another source, except as specifically permitted by the Contract Documents.

C. Provide interchangeable components of the same manufacturer for components being replaced.

1.4 Warranty

A. Unless otherwise noted for specific items, the Warranty period shall be in accordance
with Section 109.

B. Items requiring extended Warranties will be annotated in the individual Specification Section and in the EQUIPMENT AND MATERIAL CHECKLIST in the Appendix of the Project Manual.

1.5 Transportation and Handling

A. Transport and handle materials and equipment in accordance with manufacturer’s instructions.

B. Promptly inspect shipments to ensure that materials and equipment comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle materials and equipment by methods that will prevent soiling, disfigurement, or damage.

1.6 Storage and Protection

A. Store and protect materials and equipment in accordance with manufacturer’s instructions.

B. Store with seals and labels intact and legible.

C. Store weather sensitive materials and equipment in weather-tight, climate-controlled enclosures in an environment favorable to the product.

D. For exterior storage of fabricated materials and equipment, place on sloped supports above ground.

E. Cover materials and equipment subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of materials and equipment.

F. Store loose granular materials on solid, flat surfaces in a well-drained area. Prevent mixing with foreign matter.

G. Provide equipment and personnel to store materials and equipment by methods that will prevent soiling, disfigurement, or damage.

H. Arrange storage of materials and equipment to permit access for inspection. Periodically inspect to verify that products are undamaged and are being maintained in acceptable condition.

I. Provide lubricants and perform initial lubrication and all subsequent lubrication until the project is approved and accepted by the CITY. Lubricants and lubrication shall be in accordance with equipment manufacturer’s instructions.

J. Limit size and maintain stockpiles of construction materials in a manner that will not block existing drainage or be hazardous to pedestrian or vehicular traffic in any way. This limitation, relative to the stockpiling of construction materials, shall be
controlled by the OWNER. In the event the CONTRACTOR fails to satisfactorily modify their operations relative to the stockpiling of construction materials upon order of the OWNER, all Work except clean-up operations will be stopped, and remain stopped, until the order of the OWNER has been complied with.

K. Do not place stored materials within the drip line of trees.

1.7 Materials and Equipment Options

A. Materials and equipment specified by reference standards or by description only: Any material or equipment meeting those standards or description.

B. Materials and equipment specified by naming one or more manufacturers: Materials and equipment of manufacturers named and meeting Specifications, no options or substitutions allowed.

C. Materials and equipment specified by naming one or more manufacturers with a provision for or approved equal: Submit a request for consideration of any manufacturer not named in accordance with the following Article.

1.8 Substitutes and “Or Approved Equal” Items

A. The OWNER will only consider written requests for substitute and “or-approved equal” items.

1.9 Operations and Maintenance Manuals

A. Provide one searchable PDF copy and one printed copy of the Operations and Maintenance Manual including submittal data; factory and field testing reports, complete schedule of maintenance, etc. The manual shall include a numbered parts list and complete wiring, interconnection and schematic diagrams.

B. O&M Manual shall include names, addresses, location, phone number, e-mail address, and fax phone number of local supplier, installer, and factory.

2. Products

2.1 As listed in the EQUIPMENT AND MATERIAL CHECKLIST in the Appendix of the Project Manual, or as required by any of the sections of the project’s specifications, or as required by the OWNER.

2.2 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

3. Execution

3.1 General

A. The CONTRACTOR shall provide material and equipment submittals in advance of
scheduled installation to allow for review and approval by the OWNER in accordance with Section 105.

B. Illegible submittals will be returned to the CONTRACTOR without comment.

C. Verbal approval by the OWNER or the ENGINEER of material and equipment proposed by the CONTRACTOR for incorporation into the work will have no standing.

D. The CONTRACTOR shall not bring unapproved material or equipment onto the project site.

END OF SECTION
Section 01650 – Starting of System

1. General

1.1 Summary

A. This section addresses all supervision, labor, materials, and equipment in the work for furnishing and demonstrating the proper operation of all equipment, controls, and appurtenances to the satisfaction of the OWNER, ENGINEER and Virginia Department of Environmental Quality. Any water, temporary power, fuel, natural gas, or any other incidental item needed for the demonstration shall be the responsibility of the CONTRACTOR.

B. Starting of system shall be include three discrete testing phases:

1) Certified Factory Testing

2) Operational Testing

3) Final Acceptance Testing

C. The CONTRACTOR shall arrange the services of factory-trained equipment representatives to assist in calibrating and testing equipment items listed in paragraph 3.1.B for Operational Testing and paragraph 3.2.B for Final Acceptance Testing. These services shall be provided at no additional cost to the OWNER. If equipment has been furnished by the OWNER, refer to the contract documents for responsibility of the services of factory-trained equipment representatives to assist in calibrating and testing equipment.

D. Additional start-up and testing requirements as specified throughout the technical specifications and as recommended by the equipment manufacturer are also required.

E. Related sections

01600 Materials and Equipment
05510 Metal Stairs
05520 Handrails and Railings
05715 Fabricated Spiral Stairs
08100 Steel Doors and Frames
08310 Hatches
14630 Trolley and Runway Beam
15062 Interior Pipe, Fittings, Valves, and Specialties
15100 Vertical Extended Shaft Centrifugal Pumping Equipment
15150 Non-Clog Submersible Centrifugal Pumps and Drives
15160 Diesel-Engine Driven Emergency Pumping Systems
15163 Variable Frequency Drives
15170 Level, Pressure, and Intrusion Sensing System
15492 Fuel Gas Piping
15700 Heating and Ventilation Equipment
16140 Wiring Devices
16170 Disconnect Switches
1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Certified Factory Testing Results – To be provided to the OWNER prior to Operational Testing.
   1) Pump performance curves
   2) Pump hydrostatic tests results
   3) Standard factory back-up power system tests
   4) Factory test of the control panel

C. Operational Testing Results - To be completed and provided to the OWNER prior to Final Acceptance Testing.
   1) Operational Testing and Final Adjustment Report
   2) Ready for Final Acceptance Testing Certification

D. Final Acceptance Testing Results - To be provided to the OWNER prior to Final Acceptance of the project by the OWNER.
   1) Final Acceptance Testing and Final Adjustment Report
   2) Final Acceptance Testing Completion Certification

2. Products.
   2.1 Testing Devices

A. The CONTRACTOR shall employ all testing devices and personnel trained in their use, required for testing as specified herein. Testing devices shall have valid calibrations performed by qualified independent calibration and testing agencies certified by the testing equipment manufacturer.

3. Execution.
   3.1 Operational Testing

A. Authorization is required from the OWNER in order for the CONTRACTOR to proceed with Operational Testing. The CONTRACTOR shall perform Operational Testing of all
installed equipment, controls, alarms and appurtenances prior to the Final Acceptance Testing.

B. The CONTRACTOR shall contract with and pay for the services of the following manufacturers’ representatives to be present for Operational Testing, to assist with equipment and control adjustments and bringing the system into service, and to furnish final equipment adjustment and testing reports:

1) Sewage Pumps
2) Pump Station Control Center
3) Back-up Power System
4) Permanent Bypass Pumps
5) Sewage Grinder

C. Operational Testing shall be performed by the CONTRACTOR in the presence of the OWNER. The CONTRACTOR shall provide at their expense all equipment, utilities, expendables and labor required to perform the testing.

D. Operational Testing of pumping and control equipment components will be performed - as required to demonstrate the proper operation of individual items of equipment, components and processes. The CONTRACTOR is required to obtain a water meter and backflow assembly from the OWNER to fill the wet well from a fire hydrant. Trucked water will not be allowed unless approved by the OWNER and a spare water truck is present during testing capable of refilling the wet well for additional testing.

E. Schedule Operational Testing of individual components, groups of components or systems with the OWNER at least seven days in advance of such testing. To the maximum extent possible, all Operational Testing shall be performed on the same date. Operational Testing will not be permitted on Mondays and Fridays.

F. Operational Testing shall be performed using the Operational Testing and Final Adjustment Report Form found in Section 01000 Special Provisions. The report shall include dates of testing, test equipment utilized, person performing tests and the OWNER witness, tests made, specified or manufacturer provided comparative acceptable test results, actual test results, corrections made and results of retesting for each piece of equipment of component tested.

G. As a minimum, Operational Testing shall include demonstration of proper installation, operation and control of the following, if installed:

1) Exterior – Masonry, Roof, Trim, Paint, Louvers, Doors, Concrete, Fixtures, Hatches
2) Interior – Masonry, Ceiling, Floors, Concrete Walls, Coatings, Linings, Equipment Anchorage
3) Space Heaters – Manual and Auto
4) Lighting Systems – Exterior, Control/Equipment Rooms, and Generator Room
5) Supply Fans
6) Exhaust Fans – Manual and Auto
7) Louvers and Dampers
8) Plumbing Fixtures – Hose bibs and drains
9) Doors and Door Hardware
10) Influent and Discharge Piping
11) Gate Valves (Interior and Exterior)
12) Valve Actuators
13) Check Valves
14) Sewage Pumps and sump pump
15) Sewage Grinder
16) Emergency Power System including sound levels
17) Station Control System
18) Level Sensing System, Pressure Sensing System, and Flow Sensing System
19) Stairs and Platforms
20) Electrical receptacles

H. Upon completion of Operational Tests, the CONTRACTOR shall make all final adjustments, repairs and replacements as required to comply with the Contract Documents and retest all components to demonstrate such.

I. The CONTRACTOR shall provide written certification that the Operational Testing was satisfactorily completed, all deficiencies were corrected, initially deficient components were successfully retested and that the Station is ready for Final Acceptance Testing.

J. Once Operational Testing is satisfactorily completed and upon approval from the OWNER’S Project Manager and Operations Staff, the CONTRACTOR may take the station off of bypass pumping and start to accept sewage into the station for Final Acceptance Testing purposes. The bypass system must remain in place as a backup system for a minimum of 48 hours.
3.2 Final Acceptance Testing

A. Authorization is required from the OWNER in order for the CONTRACTOR to proceed with Final Acceptance Testing. The CONTRACTOR shall perform Final Acceptance Testing of all installed equipment, controls, alarms and appurtenances. During Final Acceptance Testing, the CONTRACTOR shall demonstrate proper repair of any items found deficient during the Operational Testing.

B. The CONTRACTOR shall contract with and pay for the services of the following manufacturers’ representatives to be present for Final Acceptance Testing, to assist with equipment and control adjustments and bringing the system into service, and to furnish final equipment adjustment and test reports:

1) Sewage Pumps

2) Pump Station Control Center

3) Back-up Power System

4) Permanent Bypass Pumps

5) Sewage Grinder

C. Final Acceptance Testing shall be performed by the CONTRACTOR in the presence of the OWNER. The CONTRACTOR shall provide at their expense all equipment, utilities, expendables and labor required to perform the testing.

D. Final Acceptance Testing of pumping and control equipment will be performed to simulate operation as a system.

E. Request Final Acceptance Testing with the OWNER at least seven days in advance of such testing. The OWNER will schedule the final acceptance testing. Final Acceptance Testing will not be permitted on Mondays or Fridays.

F. Final Acceptance Testing shall be performed using the Final Acceptance Testing and Final Adjustment Report Form found in Section 01000 Special Provisions.

G. As a minimum, testing shall include demonstration of proper operation and control of the following, if installed:

1) Influent and Discharge Piping

2) Gate Valves (Interior and Exterior) including Air Release Assemblies

3) Valve Actuators

4) Check Valves

5) Level Sensing System, Pressure Sensing System, and Flow Sensing System
6) Sewage Pumps

7) Emergency Power System

8) Station Control System

9) Any item not listed above that was found to be deficient from the Operational testing,

H. Results of testing shall be fully documented in a Final Acceptance Testing and Final Adjustment Report. The report shall include dates of testing, test equipment utilized, person performing tests, tests made, specified or manufacturer provided comparative acceptable test results, actual test results, corrections made and results of retesting for each piece of equipment of component tested.

I. Upon completion of Final Acceptance Testing the CONTRACTOR shall make all final adjustments, repairs and replacements as required to comply with the Project Documents and the OWNER provided punch list of any remaining items to be corrected by the CONTRACTOR and retest all components to demonstrate such, prior to final acceptance by the OWNER.

J. The CONTRACTOR shall provide written certification that the Final Acceptance Testing was satisfactorily completed, all deficiencies were corrected, initially deficient components were corrected and successfully retested and that the Station is ready for operation, prior to final acceptance by the OWNER.

END OF SECTION
Section 02060 – Building and Structure Demolition

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials, and equipment in the work for furnishing and installing the demolition of existing buildings and structures.

B. Related sections

01600 Materials and Equipment
02300 Earthwork
02495 Construction Vibration Monitoring
16010 Electrical General Requirements

1.2 Section Includes

A. Demolition of designated structures and appurtenances, backfilling, and removal of materials from site.

B. Demolition and removal of foundations and slabs-on-grade.

C. Disconnection and abandonment or removal of identified utilities.

D. Filling of underground structures and abandonment of piping.

E. Demolition and removal of fences.

1.3 Submittals

A. Submit shop drawings and material certifications in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Record Drawings

1) Submit in accordance with Supplemental Specification for Water and Sanitary Sewer Record Drawings.

2) Accurately record actual locations of abandoned utilities or subsurface obstructions remaining on site.

C. Permits

1) Submit copies of all required permits to the OWNER.

1.4 Regulatory Requirements

A. Comply with Laws and Regulations for demolition of structures, protection of the adjacent structures, dust control, runoff control, and sewage disposal.

B. Obtain required permits from authorities.
C. Notify affected utility companies and the OWNER before starting work and comply with their requirements.

D. Do not close or obstruct roadways or sidewalks without permits.

E. Conform to applicable procedures when hazardous or contaminated materials are encountered.

1.5 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. Hampton Roads Planning District Commission Regional Construction Standards.

C. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

2. Products

2.1 Soil Materials

A. Lime shall be in accordance with Section 200 of the effective edition of the Hampton Roads Planning District Commission Regional Construction Standards.

B. Topsoil shall be in accordance with Section 200 of the effective edition of the Hampton Roads Planning District Commission Regional Construction Standards.

C. Sand shall be defined as material complying with ASTM D2487 Unified Soil Classification System groups SW and SP.

2.2 Flowable Fill

A. Flowable fill shall be in accordance with Section 200 of the effective edition of the Hampton Roads Planning District Commission Regional Construction Standards.

3. Execution

3.1 Preparation

A. Provide, erect, and maintain temporary barriers and security devices.

B. Protect existing landscaping materials, appurtenances, and structures, which are not to be demolished.

C. Prevent movement or settlement of adjacent structures. Provide bracing and shoring.

D. Mark location of existing utilities.

E. Dewater all tanks and structures designated to be demolished; remove and legally dispose of all liquid, sludge, and scum.
F. Remove all designated equipment, piping, electrical components, and appurtenances.

3.2 Demolition Requirements

A. Conduct demolition to minimize interference with adjacent structures.

B. Cease operations immediately if adjacent structures appear to be in danger. Notify OWNER. Do not resume operations until so directed by OWNER.

C. Conduct operations with minimum interference to public or private accesses. Maintain and protect egress and access at all times.

D. Obtain written permission from adjacent property owners when demolition equipment or activity will affect their property.

E. Sprinkle work area with water to minimize dust. Provide hoses, water connections, and water for this purpose.

F. Repair or replace structures, equipment, piping, etc. that is to remain in service if they are damaged by demolition operations. The OWNER shall have sole authority to determine whether repair or replacement is appropriate.

3.3 Demolition

A. Disconnect and cap all utilities designated for removal within demolition areas, as required. Provide appropriate blind flanges, plugs, and caps for remaining piping. When piping is removed in an area to be abandoned by filling, remaining wall castings and pipes shall be plugged by filling with flowable fill.

B. Remove foundation walls and footings to a minimum of 4 feet below finished grade or as designated on the drawings. Structures less than 5 feet in depth shall be removed entirely.

C. Drill drainage holes in bottom slabs of pump stations remaining, as designated on Contract Drawings.

D. Remove concrete slabs on grade.

E. Add 200 pounds of agricultural grade lime in four equally spaced, 50 lb. layers throughout fill as the structure is being filled with sand. The top-most lime layer shall be 3-feet below finished grade.

F. Fill structures with sand and cover with 6-inch topsoil layer.

G. Remove demolished materials from site.

H. Do not burn materials on site. Leave site in clean condition.

I. Remove temporary work.

J. Fill and grade site in accordance with Section 02300 Earthwork.
K. Seed all areas of fill and other earth areas disturbed by construction operations in accordance with Section 603 the effective edition of the Hampton Roads Planning District Commission Regional Construction Standards.

3.4 Items to be Salvaged

A. All equipment is reserved for the OWNER. The OWNER will tag all items to be salvaged prior to demolition work. The CONTRACTOR shall deliver these items to the Public Utilities Operations Yard located at 3500 Dam Neck Road. Schedule delivery at least 48 hours in advance.

END OF SECTION
Section 02300 – Earthwork

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials, and equipment in the work for furnishing and installing excavation, dewatering, erosion and sediment control, backfilling, filling, compaction, sub-grade preparation and grading.

B. This section supplements Hampton Roads Planning District Commission Regional Construction Standards, effective edition.

C. Related Sections

- 01600 Materials and Equipment
- 02060 Building and Structure Demolition
- 02495 Construction Vibration Monitoring
- 03300 Cast-in-Place Concrete
- 03400 Precast Concrete Valve Vaults

1.2 Submittals

A. Submit shop drawings and material certifications in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. The CONTRACTOR shall submit, for information only, calculations prepared by a Professional Engineer licensed in the Commonwealth of Virginia for design of sheeting and shoring for excavations. The design shall include signed and sealed drawings for all components required for the excavation work, estimated deflections and settlement, and a monitoring plan to confirm such deflections/settlements are not exceeded.

C. The CONTRACTOR shall submit, for information only, a dewatering plan prepared by a Professional Engineer or Geologist licensed in the Commonwealth of Virginia for the design of the dewatering systems to include a monitoring plan to observe groundwater conditions during construction and address disposal of drainage.

D. The Engineer or Geologist shall be retained and paid for by the CONTRACTOR and shall be a professional who is regularly engaged in the design of this type of work and will provide references upon request.

E. The CONTRACTOR shall provide the name of the “Competent Person” to the OWNER'S Representative in accordance with OSHA requirements.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in text by basic designation only. The referenced publications shall be the current effective edition.

1) Hampton Roads Planning District Commission (HRPDC) Regional Construction Standards
2) Virginia Erosion and Sediment Control Handbook
3) Virginia Work Area Protection Manual
4) Occupational Safety and Health Administration
   (a) 29 CFR 1926 Safety and Health Regulations for Construction
5) American Society for Testing and Materials
   (a) ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
   (b) ASTM D1556 Standard Method for Density and Unit Weight of Soil in Place by the Sand Cone Method
   (c) ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by Rubber Balloon Method
   (d) ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes
   (e) ASTM D2922 Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Method
   (f) ASTM D3017 Standard Method for Water Content of Soil and Rock in Place by Nuclear Method

1.4 Definitions

A. Borrow: material that is removed from one location and used as fill in another.
B. CBR: California Bearing Ratio
C. Excavated Material: Material removed from the earth during earthwork operations.
D. Excavation: The removal of soil and other material encountered between existing grade and subgrade elevations indicated by the Contract Drawings and subsequent disposal of excess materials.
E. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.
F. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular base, drainage fill, or topsoil materials.
G. Unauthorized excavation: The removal of materials beyond indicated subgrade elevations or dimensions without specific direction of OWNER.
1.5 Quality Assurance

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Testing Service: The OWNER will employ and pay for a qualified independent geotechnical testing and inspection service to perform on-site soil testing, compaction testing, and inspection services.

C. All soil tests that fail to meet specified requirements shall be re-tested at the expense of the CONTRACTOR. The CONTRACTOR shall notify the OWNER’s testing agency and OWNER when work has been corrected and is ready for the re-test.

D. The CONTRACTOR shall be responsible for all costs associated with providing material certifications for re-use of on-site soil materials or for use of imported soil materials. Material certifications shall be provided by a qualified independent geotechnical testing firm.

1.6 Project Conditions

A. Site Information

1) Data in subsurface investigation reports that were used for the basis of the design is available to the CONTRACTOR for information only. Conditions shown by these reports are not intended to be representations or warranties of accuracy or continuity between soil borings. The OWNER will not be responsible for interpretations or conclusions drawn from this data by the CONTRACTOR.

2) Additional test borings and other exploratory operations may be performed by the CONTRACTOR, at the CONTRACTOR'S option; however, no change in the Contract value will be authorized for such additional exploration.

B. Existing Utilities

1) Locate existing underground utilities in areas of excavation work. Call “Miss Utility of Virginia” at 811 in accordance with the Virginia Underground Utility Damage Prevention Act. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

2) Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with the OWNER and utility owner in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

3) Do not interrupt existing utilities serving facilities occupied by the OWNER or others, during occupied hours, except when permitted in writing by the OWNER and then only after acceptable temporary utility services have been provided.

   (a) Provide minimum of 48-hour notice to the OWNER, and receive written notice to proceed before interrupting any utility.

4) Demolish and completely remove from site existing underground utilities
indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

C. The use of explosives will not be permitted.

D. Protection of Persons and Property

1) Barricade open excavations occurring as part of this work and post with warning lights.

2) Operate warning lights in accordance with the Virginia Work Area Protection Manual and as recommended by authorities having jurisdiction.

3) Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

4) No excavation will be permitted within the drip line of trees.

5) Excavation shall be performed in strict compliance with regulations of authorities having jurisdiction.

2. Products.

2.1 Soil Materials

A. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SW, and SP.

B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups ML, GC, SC, MH, CH, CL, OL, OH, and PT.

C. Select Material is defined non plastic soil material obtained from roadway cuts, borrow pits or commercial sources that is designated or reserved for use as a foundation for the Sub-base, sub-base material, shoulder surfacing, trench backfilling or other specified purposes having a minimum CBR value of 15 and shall conform to the effective edition of the Hampton Roads Planning District Commission Regional Construction Standards.

D. Sub-base Material is defined as naturally or artificially graded mixture of gravel, crushed stone, and natural or crushed sand.

E. Drainage Fill is defined as washed, evenly graded mixture of crushed stone, or gravel, with 100 percent passing a 1-1/2-inch sieve and not more than 5 percent passing a No. 4 sieve.

F. Backfill and Fill Materials are defined as soil materials that have been approved by the OWNER and are free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

3. Execution.

3.1 Excavation
A. Excavation shall be unclassified and includes excavation to subgrade elevations indicated, regardless of the character of materials and obstructions encountered.

B. Unauthorized excavation, as well as remedial work directed by the OWNER, shall be at the CONTRACTOR’S expense.

1) Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Select Material may be used to bring elevations to proper position, when acceptable to the OWNER.

2) In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by the OWNER.

C. The removal of materials beyond indicated subgrade elevations or dimensions at the specific direction of the OWNER: When excavation has reached required subgrade elevations, notify the OWNER. The CONTRACTOR shall determine if low consistency soils are present, which cannot be adequately densified in place. If the OWNER determines that the subgrade material at final grade is unsuitable, the CONTRACTOR may be directed to continue excavation until suitable bearing materials are encountered. The CONTRACTOR shall replace excavated unsuitable material with select material as directed by the OWNER. The select material shall be compacted to 95% ASTM D698 (Standard Proctor) maximum density within 2 percent of optimum moisture content.

1) Removal of unsuitable material and its replacement as directed by the OWNER will be paid on a cubic yard basis measured in place.

3.2 Stability of Excavations

A. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.

B. Slope sides of excavations to comply with local codes, ordinances, and requirements of OSHA and regulatory authorities or agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

C. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses. All shoring and bracing shall conform to OSHA standards.

3.3 Dewatering

A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding the project site and surrounding area.
1) Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.

2) Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to lower groundwater levels at least 2 feet below subgrade elevation and allow excavation to proceed in-the-dry. Discharge and convey water away from excavations.

3) Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

4) Establish and maintain erosion control measures that ensure no solids are transported off-site with water leaving the limits of the project.

B. Handling of contaminated groundwater shall be in accordance with Section 531 – Contaminated Groundwater Management of the effective edition of the Hampton Roads Planning District Commission Regional Construction Standards.

3.4 Storage of Excavated Materials

A. Stockpile excavated materials that are acceptable and necessary for backfill and fill within the site work area. Place, grade, and shape stockpiles for proper drainage.

B. Install and maintain sedimentation and erosion control devices as required to prevent the transport of stockpiled material by flowing water.

C. Excavated materials, in excess of the material used in the work or necessary for backfill and fill, shall be moved off site by the CONTRACTOR and lawfully disposed at the CONTRACTOR’S expense.

D. Locate and retain excavated soil materials away from edges of excavations. Do not store excavated material within drip lines of trees indicated to remain.

3.5 Excavation for Structures

A. Conform to elevations and dimensions shown by the Contract Drawings to a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1) Excavation for footings and foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.

2) Excavation for Underground Tanks, Basins, and Mechanical or Electrical Structures: Conform to elevations and dimensions indicated within tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for
inspection. Do not disturb bottom of excavations, intended to be a bearing surface.

3.6 Cold Weather Protection
A. Protect bottoms of excavations against freezing when atmospheric temperature is less than 35 degrees F.

3.7 Backfill and Fill
A. Place material in layers to required elevations, using materials specified herein and in Part 2 of this Section.

1) Under grassed areas, use excavated or borrow material as approved by the OWNER.

2) Under walks and pavements, use select material.

3) Under steps, use select material.

4) Under building slabs, use select material.

5) Under piping and conduit and equipment, use select material where required for filling unauthorized or additional excavation.

6) Carefully backfill trenches where trench excavations pass within 18 inches of columns or walls.

7) Do not backfill trenches until all required tests and inspections have been made and backfilling is authorized by the OWNER. Use care in backfilling to avoid damage to or displacement of pipe systems.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1) Acceptance of construction below finish grade including, where applicable, damp proofing, and waterproofing.

2) Inspection, testing, approval, and locations of underground utilities have been performed and recorded.

3) Removal of concrete formwork.

4) Removal of trash and debris from excavation.

5) Permanent or temporary horizontal bracing is in place on horizontally supported walls.

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

B. When existing ground surface has a density less than that specified in paragraph 3.8, D, 1), break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density. Place backfill and fill materials in layers not more than 8-inches in loose depth for material compacted by heavy compaction equipment, and not more than 6-inches in loose depth for material compacted by hand-operated tampers. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or that contain frost or ice.

C. Place backfill and fill materials evenly in approximately 8-inch lifts when filling adjacent to structures, piping, or conduit. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately the same elevation in each lift.

D. Control soil and fill compaction, providing minimum percentage of density specified below. Correct improperly compacted areas or lifts as directed by the OWNER if soil density tests indicate inadequate compaction.

1) Percentage of Maximum Density Requirements: Non-paved areas shall be compacted to 90 to 95 percent density per ASTM D698 within 2 percent of optimum water content. Paved areas shall be compacted to 95 percent density per ASTM D698 within 2 percent of optimum water content.

2) Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

   (a) Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

   (b) Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by diskng, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

E. Fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping, or manually directed power tampers or plate vibrators. Heavy equipment shall not be operated within two feet of any structure. Vibrating roller shall not be operated within five feet of any structure without the OWNER’S written approval. Compaction by means of a drop weight, operating from a crane or hoist, will not be permitted.

F. During construction, the passage of heavy equipment will not be allowed over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or two feet,
whichever is greater.

G. Compaction of fill adjacent to poured in place concrete structures shall not be allowed until the new concrete has reached its required design strength. Coordinate the work with the time and strength of concrete requirements provided in Section 03300. Unless otherwise identified in the work, the following represents the minimum time required prior to beginning compaction work adjacent to poured in place concrete:

1) Retaining walls and counter forts 14 days
2) Walls backfilled on both sides simultaneously 7 days
3) Conduits, precast, cradled 2 days
4) Conduits, precast, bedded 1 day

3.9 Grading

A. Uniformly grade areas within limits of grading including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

B. All ditches, swales and gutters shall be finished to drain readily. Unless otherwise indicated on the Contract Drawings, the finished grade shall be uniformly sloped to provide drainage away from building walls in all directions at grade not less than 2.0% (2 feet per 100 feet). No asphalt or concrete walks shall have less than 1% (1 foot per 100 feet) of slope.

C. No cut or fill slopes shall be steeper than 3 feet horizontal to one foot vertical. Lawn areas slopes shall not be steeper than 4 feet horizontal to one foot vertical.

D. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finished surfaces shall be free from irregular surface changes and as follows:

1) Lawn or Unpaved Areas: Finished areas to receive topsoil, to within 0.10 foot of required subgrade elevations.

2) Walks: Shape surface of areas under walks to line, grade, and cross-section indicated. Finish surface to within 0.10 foot of required subgrade elevation.

3) Pavements: Shape surface of areas under pavement to line, grade, and cross-section indicated. Finish surface to within 0.05 foot of required subgrade elevation.

E. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades with a tolerance of 0.05 foot when tested with a 10-foot straightedge.

F. Compaction: Compact subgrade surfaces to the depth of lifts indicated above and the
maximum density specified above to required final grades.

G. All filled surfaces, at building pads and roadways, shall be sealed by rolling with a steel drum or pneumatic tire roller at the end of each day to minimize surface infiltration by precipitation.

3.10 Field Quality Control

A. Quality Control Testing During Construction: As determined by the OWNER, allow the OWNER’s testing service to inspect and approve subgrade and fill layers before further backfill or construction work is performed. The CONTRACTOR shall provide the OWNER a minimum of 24 hours’ notice for any required testing.

1) Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, the calibration curves will be checked with moisture gauges in accordance with ASTM D 3017.

2) If field tests are performed using nuclear methods, calibration checks of both density and moisture gauges will be made at beginning of work, on each different type of material encountered, and at intervals as directed by the OWNER.

   (a) Footing Subgrade: For each strata of soil, on which footings may be placed, at least one test will be performed by the OWNER’s testing agency to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata when acceptable to the OWNER.

   (b) Building Slab Subgrade: At least one field density test shall be performed by the OWNER’s testing agency on the subgrade for every 2,000-sq. ft. of paved area or building slab, but in no case fewer than three tests. In each compacted fill layer, one field density test shall be performed for every 2,000-sq. ft. of overlaying building slab or paved area, but in no case fewer than three tests.

   (c) Foundation Wall Backfill: At least two field density tests shall be performed.

   (d) If, in the opinion of the OWNER, and based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, additional compaction and testing will be performed until specified density is obtained at CONTRACTOR’s expense.

3.11 Erosion and Sediment Control

A. Erosion and sediment control measures shall be in accordance with the effective edition of the Virginia Erosion and Sediment Control Handbook.

3.12 Maintenance

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather; scarify surface, reshape, and compact to required density prior to further construction.

D. Where settling is measurable or observable in areas where earthwork has been performed by the CONTRACTOR, remove surface (pavement, lawn, or other finish), determine cause of settlement, add fill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible. Corrective work shall be performed at time most convenient to the OWNER.

3.13 Disposal

A. Transport waste material, including excess excavated material, unsuitable soils, trash, and debris to lawful spoil or disposal areas and dispose of in a lawful manner at the CONTRACTOR'S expense.

END OF SECTION
Section 02495 – Construction Vibration Monitoring

1. **General**

1.1 **Summary**

A. This section addresses the work related to performing pre and post construction surveys and cooperation with the OWNER’S vibration monitoring program.

1) The OWNER will install vibration monitoring units with the CONTRACTOR present to observe their installation.

2) Establish response actions to be taken if the maximum allowable instrument readings are exceeded so that existing structures and utilities are protected from damage. Implement response actions if maximum allowable instrument readings are exceeded.

B. **Related Sections**

02060 Building and Structure Demolition  
02300 Earthwork

1.2 **Submittals**

A. Submit shop drawings and calculations in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Calculations demonstrating that the CONTRACTOR’S proposed equipment and means and methods shall comply with Threshold and Limiting Values listed in Paragraph 3.5. Submittal shall include full details of all proposed equipment necessary for demolition, excavation support installation, pile installation and extraction, and any other work activities that induce vibrations.

C. Submit one digital copy of the pre and post construction condition survey as specified herein.

D. Conformation of recommended Threshold and Limiting Values or recommendations for alternative values.

E. Submit proposed remedial measures to the OWNER of action to be taken in the event that the instrument Threshold Values are reached.

1.3 **Vibration Monitoring Program**

A. The OWNER will install seismographs to monitor ground vibration levels at adjacent structures due to CONTRACTOR activities including but not limited to demolition, excavation support installation, pile installation and extraction, or other work activities that induce vibrations.

B. Monitoring locations will be chosen by the OWNER.
1.4 Definitions

A. Seismographs: Electronic recording device with vibration transducer capable of monitoring and recording ground vibrations induced by construction activity.

1.5 Quality Assurance

A. The OWNER shall be responsible for all aspects pertaining to the installation, maintenance and monitoring of the vibration monitoring equipment specified herein.

B. Persons responsible for the vibration exceedance calculations shall be a Professional Engineer or Geologist licensed in the Commonwealth of Virginia, and shall have had a minimum of 5 years of professional experience in construction monitoring.

C. Persons responsible for pre and post construction surveys shall be Professional Engineers, licensed in the Commonwealth of Virginia, and shall have had a minimum of 5 years of professional experience in structural evaluation and conditions surveys.

1.6 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. US Department of Interior, Bureau of Mines, Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting

1.7 Design and Project Requirements

A. Pre-Construction Survey

1) Prior to start of demolition, excavation support installation, pile installation or other vibration inducing activities, conduct a pre-construction survey of existing structures and conditions within 250 feet of any anticipated demolition, excavation support installation, pile installation or other vibration inducing activities.

   (a) Coordinate dates acceptable to the OWNER and property owner. Confirm with the OWNER, in writing, the dates on which surveys are planned so representatives are present during the examination.

   (b) OWNER will give notice in writing, to the property owner and any representative of local authorities required to be present at such survey.

2) Record observations of the existing conditions for residences, buildings and other structures, which are affected.

   (a) Provide the survey consisting of a description of interior and exterior conditions. Locate cracks, damage or other defects existing and include information to make it possible to determine the effect, if any, of the
construction operations on the defect. Provide digital photographs of all observations.

3) The pre-construction survey shall consist of written documentation, video and photographs of the conditions identified.

4) Upon completion of the Pre-Construction Survey(s), the CONTRACTOR’S Professional Engineer or Geologist shall confirm whether or not the Threshold and Limiting Values listed in Paragraph 3.5 are appropriate for the structures to be monitored.

B. Alternative Threshold and Limiting Values

1) If the CONTRACTOR’S Professional Engineer or Geologist feels that alternative Threshold and Limiting Values are appropriate based upon observed field conditions, then they shall notify the OWNER in writing of such. The OWNER must approve any alternative values.

C. Post Construction Survey

1) Upon completion of all demolition, excavation support installation, pile installation and extraction or other vibration inducing activities, complete a similar examination of properties and structures where complaints of damage have been received or damage claims have been filed. OWNER will give notice to interested parties so that they may be present during the final examinations.

D. Instrument Access and Protection

1) Provide and facilitate safe access to the instruments at all times. The OWNER may perform additional monitoring in a manner that will minimize unnecessary work delays. Allow and facilitate instrument monitoring as required by the OWNER. No claim for lost production time due to this activity will be allowed.

2) Protect all instrumentation. Report all damaged or nonfunctional instrumentation to the OWNER within 8 hours.

E. Availability of Data

1) Interpretations developed by the OWNER will be available to CONTRACTOR. CONTRACTOR may observe readings at any time or take their own supplementary readings.

2) Monitoring data is the property of the OWNER and is not to be disclosed or published to third parties without the OWNER’S written permission.

3) CONTRACTOR is expected to make their own interpretations for their own purposes at no additional cost to the OWNER.

2. Products. [Not Used]
3. Execution

3.1 General Requirements

A. Perform a pre-construction survey prior to any demolition, excavation support installation, pile installation or other vibration inducing activities.

B. Perform post construction survey after all vibration inducing activities have been completed.

C. The OWNER may modify instrument locations depending on field conditions and monitoring objectives.

D. Provide the OWNER with access to instrument locations and assistance required in obtaining monitoring data.

3.2 Vibration Monitoring

A. Seismograph readings will be taken during demolition, excavation support installation, pile installation and extraction, or other activities causing ground vibrations within 250 feet of existing structures to document that peak particle velocities do not exceed the limit criteria as described below. The CONTRACTOR shall coordinate with the OWNER as necessary to permit vibration monitoring activities.

B. The OWNER will provide data from readings of all vibration monitoring units to the CONTRACTOR. The CONTRACTOR shall communicate verbally with the OWNER immediately after visual observations or data collection if excessive movements or other anomalies are indicated.

C. The CONTRACTOR shall make visual observations of ground conditions and building conditions in the vicinity of the site and communicate immediately with the OWNER if signs of ground or building movements are observed.

D. Cooperate with the OWNER during vibration monitoring by providing access to the instrumentation locations in a timely manner and by providing and maintaining safe means of access to all instrumentation locations for data collection.

E. The CONTRACTOR may make their own interpretations of monitoring data for their own purposes. Data or interpretations shall not be published or disclosed to other parties without advance written permission of the OWNER.

3.3 Instrument Protection

A. Protect the instruments from damage. The CONTRACTOR is responsible for any damage caused by their activities. The value of repairing or replacing the monitor shall be deducted from the Contract by Change Order.

B. If necessary, the CONTRACTOR will suspend work in the areas being monitored by the damaged instrument until a replacement unit is installed.
3.4 Interpretation and Response Values

A. Threshold and Limiting Values for instruments taken from US Department of Interior, Bureau of Mines:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Threshold Value</th>
<th>Limiting Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismographs</td>
<td>1.0 in/sec over 40 Hz</td>
<td>2.0 in/sec over 40 Hz</td>
</tr>
<tr>
<td></td>
<td>0.75 in/sec at 30-40 Hz</td>
<td>1.5 in/sec at 30-40 Hz</td>
</tr>
<tr>
<td></td>
<td>0.5 in/sec at 20-30 Hz</td>
<td>1.0 in/sec at 20-30 Hz</td>
</tr>
<tr>
<td></td>
<td>0.25 in/sec under 20 Hz</td>
<td>0.5 in/sec under 20 Hz</td>
</tr>
</tbody>
</table>

B. If a Threshold Value is reached:

1) OWNER and CONTRACTOR shall meet to discuss remedial measures.

2) CONTRACTOR shall implement the remedial measures in the event the Threshold Value is reached, so the Limiting Value is not reached.

C. CONTRACTOR to take all necessary steps so that the Limiting Value is not exceeded. CONTRACTOR may be directed to suspend activities in the affected area with the exception of those actions necessary to avoid exceeding the Limiting Value.

END OF SECTION
Section 03300 – Cast-In-Place Concrete

1. General

1.1 Summary

A. This section addresses all supervision, labor, materials, and equipment in the work for furnishing and installing cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

1) Cast-in-place concrete includes the following:

(a) Foundations and footings
(b) Slabs-on-grade
(c) Walls
(d) Structural Slabs
(e) Beams
(f) Control, and expansion and contraction joint devices associated with concrete work, including joint sealants
(g) Equipment pads
(h) Water stops, anchor bolts, and other embedded accessories
(i) Topping slabs
(j) Adhesive cartridge anchors
(k) Grout

B. Related Sections

01600 Materials and Equipment
02300 Earthwork
03400 Precast Concrete Valve Vaults
03930 Concrete Rehabilitation
03931 Concrete Protective Coatings
05501 Anchor Bolts and Anchors
07620 Sheet Metal Flashing and Trim
07900 Joint Sealants
08310 Hatches
09900 Painting

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.
1) Product data for proprietary materials and items, including reinforcement and forming accessories, fiber reinforcement, bonding and form release agents, patching compounds, water stops, joint systems, vapor barriers, curing compounds, dry-shake finish materials, and others if requested by OWNER.

2) Cementitious materials: Sources of cement and other supplementary cementitious materials. Indicate name and location of mill or quarry. Conformance to ASTM standards including chemical analysis and physical tests.

3) Aggregates: Conformance to ASTM Standards, including sieve analysis, mechanical properties, and deleterious substance content. Provide test results on coarse and fine aggregates for mortar bar expansion per ASTM C1260.

4) Admixtures: air-entraining, water reducing, high-range water reducing and other proposed admixtures. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, slump ranges, and conformity to ASTM standards. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

5) Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement, fly ash or ground granulated blast furnace slag as proposed. Provide either Paragraph (a) or (b) below, for each mix proposed.

   (a) Standard deviation data for each proposed concrete mix based on statistical records. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:

   1. Date of sampling and name of testing laboratory.
   2. Name of concrete batch plant.
   3. Water cementitious ratio.
   4. Slump of batch.
   5. Air content of batch.
   6. Compressive strengths of all cylinders tested at that age in that batch.
   7. If available, temperature and unit weight of batch.
   8. Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.

   (b) Water cementitious ratio curve for concrete mixes based on laboratory tests.
Provide average cylinder strength test results at 7, 14, and 28 days for laboratory concrete mix designs.

(c) Laboratory tests, per ASTM C1260 or C1567, certifying aggregates combined in the design mix meet the alkali silica reactivity limits per this specification.

6) Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.

7) Welder's certification in accordance with AWS D1.4 when welding of reinforcement is indicated, specified, or approved.

8) Formwork

(a) Formwork drawings and documents showing details of form types, methods of form construction, erection and removal methods and sequences, location of form joints and form ties and clean out openings in wall and column forms and shoring, locations and details of formwork and shoring anchorages which are located in the final concrete structure, stripping criteria and reshoring procedures. The submittal shall include drawings that clearly indicate the construction loads (location, direction and magnitude) delivered to the structure due to the formwork, shoring, stripping and reshoring and other construction activities. Where formwork and shoring anchorages are located in the final structure, provide details of anchorage removal and patching of the demolished concrete zone.

(b) Review will be for appearance, performance and strength of the completed structure only. Approval by the OWNER will not relieve the CONTRACTOR of responsibility for the strength, safety or correctness of methods used the adequacy of equipment, or from carrying out the work as shown on the Contract Drawings and as specified herein.

9) Fiber reinforcement: Submit manufacturer's data for synthetic reinforcing fibers. Identify all placements that are to contain synthetic reinforcing fibers. The fiber length and amount of fibers per cubic yard to be used for each placement shall be noted. Submit two samples of synthetic reinforcing fibers.

1.3 Quality Assurance

A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1) American Concrete Institute ACI 301, "Specifications for Structural Concrete for Buildings."

2) American Concrete Institute ACI 318, "Building Code Requirements for Reinforced Concrete."
3) American Concrete Institute ACI 350, “Code Requirements for Environmental Engineering Concrete Structures”

4) Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

B. Use only one source of cement and aggregates for the project.

C. The CONTRACTOR shall provide all forms and shoring. Design formwork in accordance with the requirements of ACI 301, ACI 318 and ACI 347. Comply with all applicable regulations and codes. Consider any special requirements due to the use of plasticized and/or retarded set concrete.

D. Concrete Testing Service: The OWNER will employ and pay for a qualified independent testing and inspection service to perform material evaluation tests and to evaluate concrete mixes. The testing service will provide all field testing and inspection services and related laboratory tests. Methods of testing shall comply with the latest applicable ASTM methods. The following items shall be tested to verify conformity with this Section.

1) Concrete placements - compressive strength (cylinders), compressive strength (cores), temperature, slump, and air content.

2) Other materials that may require field testing

E. All tests that fail to meet specified requirements shall be re-tested at the expense of the CONTRACTOR. The CONTRACTOR shall notify the OWNER’s testing agency and OWNER when work has been corrected and is ready for the re-test.

1.4 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American Association of State Highway and Transportation Officials (AASHTO)

1) AASHTO M 182 – Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

C. American Concrete Institute International (ACI)

1) ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

2) ACI 232.2 – Use of Fly Ash in Concrete

3) ACI 233 – Slag Cement in Concrete and Mortar

4) ACI 301 – Specifications for Structural Concrete for Buildings

5) ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete
6) ACI 305 – Guide to Hot Weather Concreting
7) ACI 306 – Guide to Cold Weather Concreting
8) ACI 309 – Guide for Consolidation of Concrete
9) ACI 318 – Building Code Requirements for Structural Concrete and Commentary
10) ACI 347 – Guide to Formwork for Concrete
11) ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
12) ACI SP-66 – ACI Detailing Manual

D. APA - The Engineered Wood Association
   1) Material grades and designations as specified

E. American Welding Society (AWS)
   1) AWS D1.4 – Structural Welding Code – Reinforcing Steel

F. ASTM International (ASTM)
   1) ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
   2) ASTM A704 – Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
   3) ASTM A706 – Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
   4) ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
   5) ASTM C1064 – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
   6) ASTM C1017 – Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
   7) ASTM C1077 – Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
   9) ASTM C1218 – Standard Test Method for Water-Soluble Chloride in Mortar and
Concrete


11) ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete


13) ASTM C156 - Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compound for Concrete


16) ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete

17) ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

18) ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

19) ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by Pressure Method

20) ASTM C233 – Standard Test Method for Air-Entraining Admixtures for Concrete


22) ASTM C295 – Standard Guide for Petrographic Examination of Aggregates for Concrete

23) ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

24) ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field


26) ASTM C33 – Standard Specification for Concrete Aggregates


28) ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
29) ASTM C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

30) ASTM C494 – Standard Specification for Chemical Admixtures for Concrete


32) ASTM C596 – Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement

33) ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete


35) ASTM C94 – Standard Specification for Ready-Mixed Concrete

36) ASTM C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars

37) ASTM D1752 – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction


39) ASTM E1155 – Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers

40) ASTM E 154 – Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

41) ASTM E1745 – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

42) ASTM E329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

G. Concrete Reinforcing Steel Institute (CRSI)
   1) CRSI – Manual of Standard Practice

H. National Ready Mixed Concrete Association (NRMCA)
   1) Quality Control Manual, Section 3 - Certification of Ready Mixed Concrete Production Facilities.

I. U.S. Army Corps of Engineers (USACE)
   1) USACE CRD-C 572 – Corps of Engineers Specifications for Polyvinylchloride
2. Products.

2.1 Form Materials

A. Forms, General

1) Make forms for cast-in-place concrete of wood, steel or other approved materials. Construct wood forms of sound lumber or plywood free from knotholes and loose knots. Construct steel forms to produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Paragraphs 3.9 and 3.11.

B. Forms for Exposed Finish Concrete

1) Make forms for all exposed and non-submerged exterior and interior concrete of new and unused Plyform exterior grade plywood panels manufactured in compliance with the APA and bearing the APA trademark. Provide B grade or better veneer with High Density Overlay on all faces to be in contact with concrete. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Paragraphs 3.9 and 3.11.

2) Provide rigid forms that will not deflect, move, or leak. Design forms to withstand the high hydraulic pressures resulting from rapid filling of the forms and heavy high frequency vibration of the concrete. Limit deflection to 1/400 of each component span. Lay out form joints in a uniform pattern.

3) Dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Tape, gasket, plug, and/or caulk all joints and gaps in forms to provide watertight joints that will withstand placing pressures without exceeding specified deflection limit or creating surface patterns.

C. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

D. Forms for Cylindrical Columns and Supports: Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

E. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.

1) Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.
2) For liquid retaining structures and exterior below grade walls, provide ties that have a steel waterstop tightly attached to each strut or that have a neoprene rubber washer on each strut.

3) Do not use common wire for form ties.

2.2 Reinforcing Materials

A. Reinforcing Bars: ASTM A615 Grade 60, deformed.

B. Reinforcing Bars required to be Field Bent or Welded: ASTM A706, deformed.

1) ASTM A615, Grade 60 may be substituted for ASTM A706 subject to the following:

(a) The actual yield strength of the reinforcing steel based on mill tests does not exceed the specified yield strength by more than 18,000 psi. Retests not to exceed this value by more than an additional 3,000 psi.

(b) The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement is not less than 1.25.

(c) The carbon equivalency (CE) is 0.55 percent or less.


D. Welded Plain Bar Mats: ASTM A704 and ASTM A615 Grade 60 plain bars.


F. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

1) For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs. Precast concrete blocks may be used. Precast blocks shall have wired ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete blocks shall have compressive strength equal to that of the surrounding concrete.

2) For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

G. Tie Wires for Reinforcement: 16-gauge or heavier black annealed wire.

H. Fiber Reinforcement: 100 percent virgin polypropylene fibrillated fibers conforming to ASTM C1116. The fiber length and quantity for a specific concrete mix shall be in accordance with the manufacturer’s recommendations as approved by the Engineer.
2.3 Concrete Materials

A. Portland Cement: ASTM C 150, Type II.
   1) Use one brand of cement throughout Project unless otherwise acceptable to the OWNER.

B. Fly Ash: ASTM C618, Class F. If aggregates are proven to be susceptible to alkali-silica reactivity, fly ash may be used.

C. Ground Granulated Blast Furnace Slag: ASTM C989, Grade 100 or 120. If aggregates are proven to be susceptible to alkali-silica reactivity, fly ash may be used.

D. Aggregates: ASTM C 33 for normal weight concrete (Table 4 – Moderate Weathering), ASTM C330 for lightweight concrete and as specified. Provide aggregates from a single source for exposed concrete.
   1) For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
   2) Local aggregates not complying with ASTM C 33 when normal weight aggregates are used or ASTM C330 when light weight aggregates are used that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to OWNER.
   3) The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement proposed for the project. If aggregates proposed for use do not meet this requirement, then satisfy either (a) or (b). below.
      (a) Total equivalent alkali content of the cement used shall not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C150.
      (b) The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1567 and using the cement and fly ash or ground granulated blast furnace slag proposed for the project. The proportions of the cement-fly ash mix or cement-ground granulated blast furnace slag mix shall be the same as those proposed for the project.

E. Water: Potable water free of oil, acids, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances

F. Admixtures, General: Provide concrete admixtures that conform to ASTM C233 and that contain not more than 0.1 percent chloride ions.

G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

H. Water-Reducing Admixture: ASTM C 494, Type A.
I. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
J. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

2.4 Related Materials

A. Sand Cushion: Clean, manufactured or natural sand.
B. Vapor Retarder: Shall be ASTM E 1745. Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:
   1) Polyethylene sheet not less than 8 mils thick.
C. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd., complying with AASHTO M 182, Class 2.
D. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
   1) Waterproof paper.
   2) Polyethylene film.
   3) Polyethylene-coated burlap.
E. Liquid Membrane-Forming Curing Compound: Liquid Membrane-Forming Curing Compound: Compound conforming to ASTM C309, Type 1-D (clear or translucent with fugitive dye) and containing no wax, paraffin, or oil. Curing compounds shall be non-yellowing and have a unit moisture loss no greater than 0.55 kg/m2 at 72 hours applied at 200 sq. ft. gal as measured by ASTM C156. Curing compound shall comply with Federal, State and local VOC limits.
F. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
   1) Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.
G. Bonding Agents: ASTM C 881, two-component, solvent-free, asbestos-free epoxy resin material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.
I. Floor Hardener: Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride, magnesium silicofluoride, or sodium silicofluoride. These silicofluorides can be used individually or in combination. Proprietary hardeners may be used if approved by the OWNER.
J. Waterstops: Unless noted otherwise waterstops shall be 9" wide preformed polyvinyl chloride (PVC) waterstops which meet the requirements of the Corps of Engineers Specification CRD C-572 may be used. Joints shall be spliced by heat fusion or
adhesion in strict compliance with the manufacturer’s recommendations.


L. Non-Shrink Grout: Premixed compound consisting of noncorrosive, nonstaining, non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days. The grout shall comply with ASTM C 1107 and have a minimum 30- minute working time.

2.5 Proportioning and Designing Mixes

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to OWNER for preparing and reporting proposed mix designs. Do not use the same testing agency for field quality control testing. The mix design shall meet the requirements of ACI 301 and ACI 350 and conform to the following:

1) Water retaining concrete: The concrete mix design shall obtain a minimum compressive strength of 5000 psi and shall be in accordance with the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Cement Ratio</td>
<td>.4 maximum</td>
</tr>
<tr>
<td>Slump</td>
<td>2 to 4 Inches (8” maximum if using HRWR)</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>ASTM C33 - #57</td>
</tr>
<tr>
<td>Total Cementitious Content</td>
<td>540 lb/ yd3</td>
</tr>
<tr>
<td>Air Content</td>
<td>6% (+/- 1%)</td>
</tr>
<tr>
<td>(Flyash or Slag may be included)</td>
<td></td>
</tr>
</tbody>
</table>

2) Slab-On-Soil: The concrete mix design shall obtain a minimum compressive strength of 5000 psi and shall be in accordance with the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Cement Ratio</td>
<td>.45 maximum</td>
</tr>
<tr>
<td>Slump</td>
<td>3 Inches (8” maximum if using HRWR)</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>ASTM C33 - #67</td>
</tr>
<tr>
<td>Total Cementitious Content</td>
<td>560 lb/ yd3</td>
</tr>
<tr>
<td>Air Content</td>
<td>6% (+/- 1%)</td>
</tr>
<tr>
<td>(Flyash or Slag may be included)</td>
<td></td>
</tr>
</tbody>
</table>

3) Other concrete: The concrete mix design shall obtain a minimum compressive strength as noted on the Contract Drawings and shall be in accordance with the requirements ACI 301 and ACI 350. Select Exposure Categories which represent the specific project conditions. The minimum cement contents shall be based in the aggregate sizes selected. Select the minimum compressive strength, cement type, water/cement ratio, air content and quantities of supplemental cementitious materials based on the required Exposure Class.
2.6 Admixtures

A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.

B. Use high-range water-reducing admixture in pumped concrete, concrete required to be water-tight and concrete with water-cement ratios below 0.50.

C. Use air-entraining admixture in all concrete unless otherwise indicated. Add air-entraining admixture at manufacturers prescribed rate such that the required entrained air content is provided at the point of placement. Provide the amount of entrained air in accordance with the exposure levels listed in ACI 301 and ACI 350 and based on the aggregate sizes provided. The tolerances on the actual entrained air levels shall be +/- 1½%.

D. Supplemental Cementitious Materials: Provide, as required, Flyash and/or ground granulated blast furnace slag. The maximum amounts of these materials shall be in accordance with ACI 301 and ACI 350 unless greater amounts are approved by the OWNER.

E. If aggregates are determined to be susceptible to alkali-silica reactivity, include flyash, slag or other ASR reducing admixtures in the proposed concrete mixes in order to mitigate the occurrence of future alkali-silica reactions.

2.7 Concrete Mixing

A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.

1) Discharge shall be completed within 1½ hours after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. When air temperature is between 85 deg F and 90 deg F, reduce the discharge time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F, reduce the discharge time to 60 minutes.

2) Concrete must be produced at a certified plant. No on-site batch processing will be permitted for all reinforced and unreinforced concrete.

3. Execution

3.1 General

A. Coordinate the installation of joint materials, vapor retarder/barrier, pipe penetrations, wall sleeves, hatches, and other related materials with placement of forms and reinforcing steel.

B. Slabs shall be poured monolithically. Reinforcing and forms shall be maintained wet prior to concrete placement.
3.2 Forms

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

1) Provide Class A tolerances for concrete surfaces exposed to view. Permitted irregularities are 1/8” for both gradual and abrupt.

2) Provide Class C tolerances for other concrete surfaces. Permitted irregularities are 1/2” for gradual and 1/4” for abrupt.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

C. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.

D. Unless otherwise noted on the Contract Drawings provide a minimum 3/4-inch chamfer for top of wall and on all exposed corners and edges. For exterior top slab of pump station structure use 2-inch chamfer. Create chamfers using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

E. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

F. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 Vapor Retarder/Vapor Barrier Installation

A. General: Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour. Provide under all slabs-on-grade, in accordance with the Contract Drawings.

B. Lap joints 6 inches and seal with manufacturers recommended mastic or pressure-sensitive tape.
3.4 Placing Reinforcement

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.

1) Avoid cutting or puncturing vapor retarder/vapor barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, plastic chairs, bolsters, and concrete Brick, as approved by the OWNER.

D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. Minimum concrete cover, unless noted otherwise:

1) Concrete cast against and permanently exposed to earth. 3 in.

2) Concrete surfaces exposed to sewage:

   (a) Elevated Slabs and Base Slabs 3 in.

   (b) Beams and Columns:

      (1) Stirrups, spirals and ties 2 ½ in.

      (2) Primary Reinforcement 3 in.

      (3) Walls 3 in.

3) Concrete exposed to earth, liquid, weather, or bearing on work mat or slabs supporting earth cover:

   (a) Elevated Slabs, Base Slabs and Footings 2 in.

   (b) Beams and Columns:

      (1) Stirrups, spirals and ties 2 in.

      (2) Primary Reinforcement 2 1/2 in.

      (3) Walls 2 in.

E. Minimum length of tension lap slices shall be in accordance with ACI 350 for Class B splice, unless otherwise noted on the Contract Drawings, but not less than 12 inches.
F. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces in accordance with ACI 350. The minimum lap splice length shall not be less than one spacing of cross wires plus 2 in or not less than 12 in, whichever is larger. Tie the spliced fabrics together with wire ties spaced not more than 24 inches on center and lace with wire of the same diameter as the welded wire fabric. Offset laps of adjoining widths to prevent continuous laps in either direction.

G. Reinforcing steel interfering with the location of other reinforcing steel, piping, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Obtain the approval of the OWNER if greater displacement of bars to avoid interference is needed. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the OWNER.

H. Do not weld reinforcing steel bars either during fabrication or erection unless indicated on the Contract Drawings or as specified herein, or unless prior written approval has been obtained from the OWNER. Comply with AWS D1.4 when welding of reinforcement is shown on the Contract Drawings, specified, or approved.

I. Do not field bend reinforcing unless indicated or specifically authorized in writing by the OWNER. Cold-bend bars indicated or authorized to be field bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. Replace, repair by cutting out damaged bars and splicing new bars using coupling sleeves filled with ferrous material, or otherwise repair damaged reinforcing bars as directed by the OWNER at no additional cost to the OWNER. Do not bend reinforcement after it is embedded in concrete unless indicated on the Contract Drawings.

J. Where reinforcing dowels are required and the CONTRACTOR elects to not penetrate the forms for their installation, steel threaded reinforcing bar couplers shall be provided for dowel installation during subsequent concrete placements.

3.5 Joints

A. Locate all joints where indicated on the Contract Drawings.

B. Construction Joints

1) Locate and install construction joints so they do not impair strength or appearance of the structure, as shown by the Contract Drawings and as acceptable to the OWNER.

2) Construction joints shall be formed with a shear key which has a depth of 1/3 the concrete thickness. Reinforcing bars shall be continuous through the joint.

3) If joint pattern is not shown, provide wall joints not exceeding 18 ft. in either direction.

C. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
D. Expansion Joints

1) Expansion joints shall be provided if shown on the Contract Drawings. The joint filler material shall be firmly placed against the face of the completed concrete work before the concrete of the adjoining portion is placed. Reinforcement or other embedded metal items bonded to the concrete shall not be permitted to extend continuously through any expansion joint unless shown otherwise on the Contract Drawings or approved by the OWNER’S Representative.

3.6 Installing Embedded Items

A. All sleeves, anchor bolts, pipe anchors, inserts and embedded items shall be placed in positions prior to concreting. All such items must be clearly located on the shop drawings and shall be approved by the OWNER’S Representative. The CONTRACTOR shall coordinate and verify all mechanical, electrical and architectural drawings for the location of sleeves, pipes, ducts and all other items. Anchor bolt threads shall be protected with a coat of grease before placing concrete, after which they shall be thoroughly cleaned, regreased and wrapped in burlap. All ferrous metal inserts shall be galvanized.

B. The CONTRACTOR shall hold all embedded items in position and alignment during placement of concrete using templates, supplementary supports, ties or other approved means. Such supports or hardware, which will remain permanently in the concrete, shall be evaluated for their effect in shield integrity and shall be documented by photographs.

C. No items made of aluminum are allowed to be embedded in concrete unless otherwise shown on Contract Drawings. Aluminum surfaces in contact with concrete shall be given a heavy coat of an alkali-resistant bituminous paint before installation. Aluminum surfaces to be embedded in concrete shall be given one coat of zinc chromate primer.

D. Correct all embedded items not installed in the location or alignment needed or displaced by concrete placement at no additional cost to the OWNER.

E. Post installed anchors may be set with epoxy adhesive in accordance with the manufacturer’s recommendations and with the OWNER’s approval.

3.7 Preparing Form Surfaces

A. General: Coat contact surfaces of forms with an approved, non-residual, low-VOC, form-coating compound before placing reinforcement.

B. Clean, repair, remove projecting nails and fill holes, and smooth protrusions on all form surfaces to be in contact with concrete before reuse. Do not reuse forms for exposed concrete unless a "like new" condition of the form is maintained that will produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels.

C. Do not allow excess form-coating material to accumulate in forms or come into
contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

1) Coat steel forms with a non-staining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.8 Concrete Placement

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Before placing structural reinforced concrete, the OWNER, or designee, will perform all inspections required by the Special Inspections Program and will approve all formwork and reinforcing steel installations prior to the commencement of concrete placement.

C. General: Comply with ACI 304 and as specified.

D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

E. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, slump will be determined at point of truck discharge and air content will be determined at point of placement.

F. Placing Concrete in Forms

1) Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

2) Consolidate placed concrete by mechanical vibrating equipment. Use equipment and procedures for consolidation of concrete complying with ACI 309.

3) Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

4) Before placing structural/reinforced concrete, OWNER will perform Special Inspections and approve forms and reinforcing for concrete placement.
G. Placing Concrete Slabs

1) Deposit and consolidate concrete slabs in a continuous operation until completing placement of a panel or section.

2) Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.

3) All concrete for the top most elevated floor slabs, with dry or wet space below, shall be placed in one monolithic placing operation so as to eliminate the need for joints in the slab unless otherwise approved by OWNER prior to placing concrete.

4) Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

5) Maintain reinforcing in proper position on chairs during concrete placement.

H. Cold-Weather Placement

1) Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

2) When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.

3) Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

4) Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs and specifically approved by the OWNER.

I. Hot-Weather Placement

1) When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

2) Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is CONTRACTOR’S option.

3) Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
4) Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.

5) Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to the OWNER.

3.9 Finishing Formed Surfaces

A. Ordinary Surface Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Rubbed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp-proofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

3.10 Monolithic Slab Finishes

A. The flatness of all slab surfaces shall meet ASTM E 1155 flatness values Overall Ff =38 / Fl =25 and Local Ff =26 / Fl =17. Outdoor slabs shall be sloped to drain a minimum of 1/8 inch per foot.

B. Slab Finish Descriptions

1) Steel Trowel Finish: Finish by screeding and floating with straightedges to bring the surfaces to the elevations indicated. While the concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, the surface shall be wood floated to a true, even plane with no coarse aggregate visible. Apply sufficient pressure on the wood floats to bring moisture to the surface. After surface moisture has disappeared, hand steel trowel to produce a smooth, impervious surface, free from trowel marks. Trowel the surface again for the purpose of burnishing. The final troweling shall produce a ringing sound from the trowel. Do not use dry cement or additional water in troweling.

2) Wood Float Finish: Finish by screeding with straightedges to bring the surfaces to the elevations indicated. Use a wood float to compact and seal surface. Remove all laitance and leave a clean surface.

3) Light Broomed Finish: Steel trowel finish the concrete, as specified above but omit the final troweling and finish the surface by drawing a fine-hair broom lightly across the surface. Broom in the same direction and parallel to expansion joints, or in the case of inclined slabs, perpendicular to the slope, or except as directed otherwise.

4) Broomed Finish: Steel trowel finish the concrete, as specified above but omit the
final troweling. While the concrete is still soft enough, finish the surface with a stiff coarse fiber broom to produce the pattern and depth of scoring as approved by the OWNER.

C. Schedule of Slab Finishes

1) Concrete for exterior on stairs and other horizontal areas - Broomed finish, non-slip.

2) Concrete for interior walking surfaces excluding stairs - wood float finish.

3) Concrete for interior stairs - Light broomed finish, non-slip.

4) Concrete stairs, landings and platforms below normal water level in liquid retaining structures - Broomed finish, non-slip.

5) Tops of curbs and pads - Steel trowel finish.

6) Concrete on which liquids flow or are contained - Steel troweled finish.

7) Concrete slabs to be covered with grout - Broom finish as approved.

3.11 Miscellaneous Concrete Items

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

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Contract Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment. Prior to placing concrete equipment pads or floor toppings, scrub existing concrete surface clean, remove oil and grease by chipping or grinding and roughen substrate concrete surface. The cleaned surface shall be rinsed with clean water and kept saturated for the 24-hour period immediately preceding the placement of the concrete/topping. Immediately before the concrete/topping is applied the concrete surface shall be coated with neat Portland cement slurry having the consistency of paint.

3.12 Concrete Curing And Protection

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. For cold weather placements, follow the guidelines of ACI 306 and for hot weather placements, follow the guidelines of ACI 305. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating and troweling.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7
days.

1) Curing Methods: Cure concrete to retain moisture and maintain a temperature of at least 50 Degrees F at the concrete surface for a minimum of seven days after placement. Use the following curing methods as specified: Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit the surface of the concrete to dry out at any time during the curing period. Temperature of curing water shall be within 20 Degrees F of the concrete temperature.

2) Sheet Material Curing: Cover entire surface with sheet material. Anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.

3) Liquid Membrane Curing: Apply over the entire concrete surface except as follows. Curing compound shall NOT be placed on any concrete surface where additional concrete or grout is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Apply curing compound as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Apply in compliance with the manufacturer's recommendations.

C. Specified applications of curing methods:

1) Slabs for Liquid Retaining Structures: Water curing only.

2) Slabs on Grade and Footings (not used to retain liquids): Water curing, sheet material curing or liquid membrane curing.

3) Structural Slabs (other than Liquid Retaining Structures): Water curing, sheet material curing or liquid membrane curing.

4) Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.

5) Formed Surfaces: None if nonabsorbent forms are left in place seven days. Water curing if absorbent forms are used. Water curing if forms are removed prior to seven days. [Sheet cure or liquid membrane cure if forms are removed prior to seven days.] Exposed horizontal surfaces of formed walls or columns shall be water cured for seven days or until next placement of concrete is made.

6) Surfaces of Concrete Joints: Water curing or sheet material curing.

3.13 Removing Forms

A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing
and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum 28-day compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.14 Reusing Forms

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as approved by the OWNER.

3.15 Floor Hardeners

A. After 28 days, minimum, concrete cure, apply chemical hardener in three applications to a minimum total coverage of the undiluted chemical of 100 sq ft per gallon and in accordance with manufacturer's recommendations.

B. During application, area shall be well ventilated. Precautions shall be taken when applying silicofluorides due to the toxicity of the salts.

C. Any compound that contacts glass or aluminum shall be immediately removed by flushing with clear water.

3.16 Concrete Surface Patching and Repairs

A. Allow the OWNER to inspect concrete surfaces immediately upon removal of forms.

B. As soon as the forms have been stripped and the concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

C. Immediately after removal of forms remove tie cones and metal portions of ties. Fill holes promptly upon stripping using a dry-pack mortar.

D. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when approved by the OWNER.

E. Mix dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine
aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.

1) Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete; but, in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.

2) For surfaces exposed to view, blend white Portland cement and standard Portland cement in accordance with ASTM C595 so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

F. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of the OWNER. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1) Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, to the OWNER’s satisfaction, remove and replace the concrete.

G. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1) Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01-inch-wide or that penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.

2) Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

3) Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when approved by the OWNER.

H. Perform structural repairs with prior approval of the OWNER for method and procedure, using specified epoxy adhesive and mortar.

I. Repair methods not specified above may be used, subject to prior approval by the OWNER.
3.17 Quality Control Testing During Construction

A. General: The OWNER will employ an independent testing agency conforming to ASTM E329 to perform tests and to submit test reports.

B. Sampling and testing for quality control during concrete placement may include the following, as directed by the OWNER.

1) Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

   (a) Slump: ASTM C 143; one test at point of discharge at the beginning of the pour for each day’s pour and each type of concrete; then one additional test for each 5 trucks; and additional tests when concrete consistency seems to have changed.

   (b) Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one test per truck for first 3 trucks and if satisfactory then every fifth truck for each day’s pour of each type of air-entrained concrete.

   (c) Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below, when 80 deg F and above, and one test for each set of compressive-strength specimens.

   (d) Compression Test Specimen: ASTM C 31 or ASTM 192; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.

   (e) Compressive-Strength Tests: ASTM C 39; one set for each day’s pour exceeding 5 cu. yd. plus additional sets for each 50-cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

2) When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

C. Test results will be reported in writing to the OWNER, ready-mix producer, and the CONTRACTOR within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the OWNER. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed and approved by the OWNER.

3.18 Field Control

A. The OWNER may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work. The right of the OWNER to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve the CONTRACTOR from meeting the requirements of these Specifications.

B. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes with an approved concrete repair mortar. The work of cutting, testing and repairing the cores will be at the expense of the CONTRACTOR if defective work is uncovered. If no defective work is found, such cost will be at the expense of the OWNER.

3.19 Failure to Meet Requirements

A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the specified compressive strengths, the OWNER may require changes in proportions or materials, or both, to apply to the remainder of the work. Furthermore, the OWNER may require additional curing on those portions of the structure represented by the test specimens which fall below the specified compressive strengths. The cost of such additional curing shall be at no additional cost to the OWNER. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the OWNER may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the OWNER. In such cases of failure to meet strength requirements the CONTRACTOR and the OWNER shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94.

END OF SECTION
Section 03400 – Precast Concrete Valve Vaults

1. General

1.1 Summary

A. This section addresses all supervision, labor, materials, and equipment in the work for furnishing and installing Precast Concrete Structural Sections, pipe connectors and accessories, placement procedures, and finishes.

B. Related Sections

01600 Materials and Equipment
02300 Earthwork
03300 Cast-in-Place Concrete
03930 Concrete Rehabilitation
03931 Concrete Protective Coatings
05501 Anchor Bolts and Anchors
08310 Hatches

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Copy of Certificate or Report showing that the Precast Concrete Manufacturer conforms to Paragraph 1.4 of this Specification Section.

C. Calculations and Details of all precast concrete structural sections, including buoyancy calculations to be performed by and sealed by A Professional Engineer, registered in the Commonwealth of Virginia, employed by the Manufacturer showing or charting the following:

1) Manufacturer's Part No. or Catalogue No.
2) Inside diameter and height excluding base slab.
3) Wall thickness and base or top thickness where applicable.
4) Handling weight and lifting hole or loop description and locations.
5) Wire size, spacing, location, and steel area provided per vertical foot.
6) Reinforcing bar grade, size, spacing and location.
7) Design load for the top and bottom slab sections.
8) Concrete mix number and design strength.
9) Height, width, slope and annular space of the tongue & groove.

D. Pipe Connector Details, Material Specification and pipe installation procedure.
E. Joint Material Details and Material Specifications. Calculations showing the flexible Joint Sealant cross section is greater than the joints annular space times its height shall be provided when butyl rope internal seals are proposed.

F. Lifting Device and Hole Details that include design loads.

G. Concrete mix design listing all components and proportions of ingredients of the concrete to be used in the manufacture of the precast concrete components. Include 28-day compressive strengths, cement type and cement mill certificate, supplemental cementitious materials and cement mill certificate, aggregate gradations, water cement ratios, entrained air contents and data sheets for all admixtures.

H. Calculations or test results verifying that the lifting device components and holes are designed in accordance with OSHA Standard 1926.704.

I. Concrete 28-day compression strength results for every day production of Precast Components for the project was performed, showing the required strength according to the guidelines established in ACI 318.

J. Reinforcing and Cement mill certificate for materials used in the Manufacture of Precast Components for this project.

K. The above test reports for similar Precast Components recently produced, submitted prior to production of Precast Components for this project.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. Pre-stressed Concrete Institute (PCI)

1) PCI - MNL 116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

2) PCI – MNL 120 - Design Handbook Precast and Prestressed Concrete

C. National Precast Concrete Association (NPCA)

1) Quality Control Manual for Precast Concrete Plants

D. American Society for Testing and Materials

1) ASTM A416 – Standard Specification for Steel Strand, Uncoated Seven- Wire for Prestressed Concrete

2) ASTM A615 – Standard Specification for Deformed and Plain Carbon- Steel Bars for Concrete Reinforcement

3) ASTM A706 – Standard Specification for Low-Alloy Steel Deformed and Plain
Bars for Concrete Reinforcement

4) ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed

5) ASTM C33 – Standard Specification for Concrete Aggregates

6) ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens


8) ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete

9) ASTM C361 – Standard Specification for Reinforced Concrete Low-Head Pressure Pipe

10) ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

11) ASTM C494 – Standard Specification for Chemical Admixtures for Concrete

12) ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

13) ASTM C857 – Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures


15) ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures

16) ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures

17) ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals

18) ASTM C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars


20) ASTM C1037 – Practice for Inspection of Underground Precast Concrete Utility Structures

21) ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete

Revised 2020  03400/3
E. American Association of State Highway and Transportation Officials (AASHTO)

1) AASHTO M198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

F. American Concrete Institute (ACI)

1) ACI 318 - Building Code Requirements for Structural Concrete and Commentary
2) ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

G. Occupational Safety and Health Administration (OSHA)

1) Standard 1926.704 - Requirements for Precast Concrete

1.4 Qualifications

A. The Precast Manufacturer shall comply with one of the following requirements:

1) Manufacture Precast Components for the project in a plant certified in the Prestressed Concrete Institute's (PCI) Plant Certification Program.
2) Manufacture Precast Components for the project in a plant certified in the National Precast Concrete Association's (NPCA) Plant Certification Program.
3) Retain an independent testing or consulting engineering firm approved by the OWNER for Precast Plant Inspection. The basis for Plant Inspection shall be the National Precast Concrete Association Quality Control Manual or the Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products. The above firm shall inspect the Precast Plant two weeks prior to and at one week intervals during production of materials for this project and issue a report, certified by a Professional Engineer, registered in the Commonwealth of Virginia, that materials, methods, products, and quality control meet the Requirements of the above quality control manuals. Tests and inspections shall be paid by the CONTRACTOR.

B. Concrete compressive strength testing shall be performed in a laboratory inspected by the CCRL of the National Bureau of Standards. Testing shall be performed by Grade I ACI Certified Laboratory Technicians or by Level I PCI Certified Technicians. Testing shall be paid by the CONTRACTOR.

1.5 Quality

A. The manufacturer shall be responsible for the performance of all acceptance tests as specified herein and in ASTM C478. In addition, any or all precast concrete products to be installed under this Contract may be inspected at the plant for compliance with these Specifications by the OWNER, by an independent testing laboratory provided by the OWNER, or by other representative of the OWNER. The CONTRACTOR shall require the manufacturer’s cooperation in these inspections. The cost of
inspection of all products approved for this Contract will be borne by the CONTRACTOR.

B. Care shall be taken in shipping, handling, and installation to avoid damaging the products. Any products damaged in shipment shall be replaced as directed by the OWNER.

C. Inspections of the products will also be made by representatives of the OWNER after delivery and after installation. The products shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though they may have been accepted as satisfactory at the place of manufacture. Products rejected after delivery shall be marked for identification and shall be removed immediately from the work site.

D. Any precast concrete product showing a crack or damage, or which has received a blow that may have caused an incipient fracture, even though such fracture is barely visible, shall be marked as OWNER rejected and immediately removed from the work site. The OWNER’S opinion regarding such observations and rejections shall be final.

1.6 Inspection, Test Reports, Markings and Submittals

A. All precast concrete products to be installed under this contract shall be inspected and tested at the place of manufacture to verify compliance with the Specifications and Contract Drawings.

B. The manufacturer shall perform factory testing as specified herein. Copies of test reports shall be submitted to the OWNER before the product is shipped to the project.

C. In the event that any of the test results fail to meet the Specifications, no products represented by such tests shall be shipped to the job site and shall be subject to rejection. The CONTRACTOR may perform additional tests upon the products represented by the failed tests if he desires to verify the accuracy of the original tests. The ENGINEER will review the test results and advise the OWNER regarding the suitability of the products.

D. Products, which have been rejected by the OWNER, shall not be shipped to the site or shall be removed from the site of the work by the CONTRACTOR and replaced with products, which meet the Contract Specifications and Contract Drawings.

E. Prior to the shipment of each product to the site, the CONTRACTOR shall submit to the OWNER test reports and certifications as described below duly certified by the manufacturer’s approval testing facility representative or an independent certified testing laboratory demonstrating full compliance with the Contract Specifications and Contract Drawings.

F. An original plus two copies of the following shall be submitted to the OWNER.

1) The name, address, and phone number of the product manufacturer and the location of the plant at which it was manufactured.

2) Certification and certified test reports for each product (by number) of the tests
performed on concrete and concrete cores showing the results of the tests.

G. Imperfections in and minor damage to the concrete may be repaired with epoxy mortar subject to the approval of the OWNER, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Epoxy mortar shall be used for repairs and shall have a minimum compressive strength of 4,000 psi at the end of seven days, and 5,000 psi at the end of 28 days when tested in three-inch by six-inch cylinders stored in the standard manner. No repairs shall be made until the imperfections or damage has been inspected by the OWNER, and repairs authorized in writing. Repairs made prior to such authorization will be cause for rejection of the component. Pieces proposed for repair at the factory shall be set aside for periodic inspection at the factory by the OWNER. Inspections will not be made more frequently than once per month. Rejected pieces shall not be shipped to or used for the work.

H. Precast concrete structures may be rejected for any of the following reasons:

1) Exposure of any reinforcement, wires, positioning spacers or chairs used to hold the reinforcement cage in position.

2) Reinforcing steel to be in excess of ½-inch out of the specified position within cores.

3) Any shattering or flaking of concrete.

4) Voids which can be detected on the interior and exterior surfaces exceeding ¼-inch in depth.

5) Unauthorized application of any repair or coating.

6) A deficiency greater than ¼-inch from the specified wall thickness.

7) A variation from the specified internal diameter in excess of 1%.

8) Defects that indicate incorrect molding of concrete or any surface defect indicating honeycomb or other voids.

9) Any of the following cracks:

   (a) A crack having a width of 0.005 inches to 0.01 inches throughout a continuous length of 36 inches or more.

   (b) A crack having a width of 0.01 inches to 0.03 inches or more throughout a continuous length of 12 inches or more.

   (c) Any crack greater than 0.005 inches extending through the wall and having a length in excess of the wall thickness.

   (d) Any crack showing two visible lines of separation for a continuous length of two feet or more, or an interrupted length of three feet or more anywhere in evidence both inside and outside.
2. **Products.**

2.1 Materials

A. Concrete shall conform to ASTM C478 and ACI as follows:

1) Compressive strength: 4000 psi minimum at 28 days.
2) Air Content:
   
   (a) For aggregate ¾” or smaller: 7.5% +/- 1.5%.
   
   (b) For aggregate 1” or larger: 6% +/- 1.5%.
3) Alkalinity: Minimum of 50% calcium carbonate equivalent for bases, risers, and cones.
4) Cementitious Materials: ASTM C150, Type II. Minimum of 470 lbs per cy
5) Supplemental Cementitious Materials:
   
   (a) Fly Ash: ASTM C618 Class F
   
   (b) Slag Cement: ASTM C989 Grade 100 or 120
6) Coarse Aggregates: ASTM C33. Sound, Crushed, Angular Limestone. Smooth or rounded stone shall not be used.
8) Chemical Admixtures: ASTM C494. Calcium Chloride or admixtures containing calcium chloride shall not be used.

B. Reinforcing steel shall be ASTM A615 grade 60 deformed bar, ASTM A1064 wire or welded wire fabric.

C. Reinforcing bars required to be field bent or welded shall be ASTM A706 grade 60 deformed bar.

D. Flexible Joint Sealants shall be butyl rubber based conforming to AASHTO M-198, Type B - Butyl Rubber and as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100 degrees F.

E. The outside of all below-grade joints shall be sealed with an eight-inch-side, adhesive butyl rubber sealant strip with Ethylene Propylene Diene Monomer (E.P.D.M.) rubber backing. (ASTM C-990, Paragraph 6.2) The strip shall be installed only after the non-shrink grout has cured at least 72 hours and the surface has been prepared and primed.
in accordance with the manufacturer’s printed directions.

1) The CONTRACTOR shall obtain concurrence of the OWNER’S Inspector regarding the adequacy of concrete surface preparation before applying butyl rubber sealant strip.

F. Epoxy Gels for interior patching of wall penetrations shall be a 2-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive meeting ASTM C-881, Type I and II, Grade 3, Class B and C, Epoxy Resin Adhesive.

2.2 Components

A. Precast Component Fabrication and Manufacture shall be as described in this paragraph and as described in the paragraphs for the specific components.

1) Precast Manufacturing shall be in conformance with ASTM C478. Wall and inside slab finishes resulting from casting against forms standard for the industry will be acceptable. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks, and minor depressions, chips and spalls will be tolerated. Dimensional tolerances shall be those set forth in the appropriate References and specified below.

2) Joint Surfaces between Bases and Risers shall be manufactured to the joint surface design and tolerance requirements of ASTM C361. The maximum slope of the vertical surface shall be 2%. Surfaces between Bases and Risers shall be manufactured to the joint surface design and tolerance requirements of ASTM C361.

3) Lift Inserts and Holes shall be sized for a precision fit with the lifting devices, shall comply with OSHA 1926.704, and shall not penetrate through the structure wall.

B. Precast Base Sections shall be cast monolithically without construction joints or with an approved galvanized or PVC waterstop in the cold joint between the base slab and the walls. The width of the base extensions on Extended Base Structures shall be no less than the base slab thickness.

C. Precast Riser Sections shall have a minimum height of 16 inches.

D. Precast Flat Slab Top Sections shall be designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into Special Flat Slab Tops shall be sized to fit within the structure ID and the top and bottom surfaces.

E. Pipe to Precast Structure Connectors shall conform to ASTM C923. The location of the pipe connectors shall vary from the location shown on the Contract Drawings no more than 1/2 inch vertically and 5 degrees horizontally.

F. Joints between Precast Components shall be sealed internally between the tongue and the groove and additionally around the external perimeter as follows:
1) External Seals shall consist of an E.P.D.M. rubber backed flat butyl rubber sheet no less than 1/16-inch thick and eight inches wide applied to the outside perimeter of the joint.

2) Internal Seals shall consist of a plastic or paper-backed butyl rubber rope having a cross-sectional area no less than the annular space times the height of the joint.

G. Lifting devices for handling Precast Components shall be provided by the Precast Manufacturer and shall comply with OSHA Standard 1926.704. Lifting loops shall be ASTM A416 steel strand. Lifting loops made from deformed bars are not allowed.

2.3 Configuration

A. Precast structures are to be constructed as shown on the Contract Drawings.

B. The number of joints shall be minimized.

3. Execution

3.1 Examination

A. Inspect Precast Structure Components prior to unloading from the delivery truck.

3.2 Preparation

B. Product Delivery, Storage, and Handling: Coordinate delivery with the manufacturer, handle and store the Precast Components in accordance with ASTM C891 and the manufacturer's recommendations using methods that will prevent damage to the components and their joint surfaces.

3.3 Placing Structure Sections

A. Excavate to the required depth and remove materials that are unstable or unsuitable for a good foundation. Prepare a level, compacted foundation extending six inches beyond the precast structure and any added extended base.

B. Set base plumb and level.

C. Set risers, taking particular care to clean, prepare and seal joints.

D. After joining structure sections, apply the butyl sealant sheet around the outside perimeter of the joint.

E. Lift Holes leaving less than two inches of wall thickness shall be plugged from the outside using a sand cement mortar, then covered with butyl sealant sheet. Lift Holes penetrating the wall shall be additionally sealed with an interior application of an epoxy gel 1/8-inch thick extending two inches beyond the penetration.

F. Perform the final finishing of the precast structure’s interior by filling all chips or fractures greater than ½-inch in length, width or depth and depressions more than ½-inch deep with a sand cement mortar. Do not fill the joints between the precast
concrete sections. Clean the interior of the structure, removing all dirt, spills or other foreign matter.

END OF SECTION
Section 03930 – Concrete Rehabilitation

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials, and equipment in the work for furnishing and installing concrete rehabilitation or repair procedures and materials, including formwork, reinforcing, mix design, placement procedures, and finishes required to prepare concrete surfaces for concrete protective coatings.

B. **Related Sections**

   01600 Materials and Equipment
   03300 Cast-in-Place Concrete
   03400 Precast Concrete Valve Vaults
   03931 Concrete Protective Coatings

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

   1) Design Data
   2) Prepackaged Materials

B. **Instructions**

   1) Epoxy repair material - Submit for mixing and applying.

   2) Coating – Surface preparation; mixing; curing; application methods; rates and thickness; and holiday detection and repairing

C. **Reports**

   1) Sieve analysis test for aggregate

   2) Epoxy resin binder – include the following:

      (a) Viscosity
      (b) Consistency
      (c) Gel time
      (d) Absorption
      (e) Shrinkage
      (f) Thermal compatibility

   3) Epoxy resin grout tests - include the following:
(a) Epoxy number
(b) Consistency
(c) Compressive single shear strength
(d) Bonding strength
(e) Pot life

D. Product Experience and Test Data – Coating

1) Provide documentation including project information, reference, and contact information regarding at least five similar coating applications that have been in service for five years.

2) Provide certified test data documenting compliance with applicable standards for epoxy coatings used in acid environments.

E. Certificates - Training and Qualifications

1) All personnel associated with the mixing, handling, and placing of epoxy products shall be certified for a minimum of three years by the manufacturer as trained, shall have a minimum of five similar successful coating applications, and shall be qualified to perform all operations in accordance with the requirements of the manufacturer and these Contract Documents. Submit training and qualification certificates for the following products:

(a) Epoxy resin binder
(b) Epoxy grout
(c) Coating

F. Records

1) Provide a diagram that maps and locates spalled areas including:

(a) Wall label
(b) Spalled area sequence number
(c) Rectangular dimensions of spall
(d) Maximum depth of spall
(e) Approval of OWNER’s Inspector including name, signature, and date

2) Application and delivery records of epoxy binder and aggregate shall be submitted to the OWNER daily during repair operations including:
(a) Delivery tickets
(b) Storage location and temperature
(c) Date container and/or package received
(d) Date container and/or package opened
(e) Mix proportions
(f) Spalled area sequence number to which epoxy is applied

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The referenced publications shall be the current effective edition.

B. American Society for Testing and Materials (ASTM)

4) ASTM C144 – Standard Specification for Aggregate for Masonry Mortar
5) ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
6) ASTM C321 – Standard Test Method for Bond Strength of Chemical – Resistant Mortars
7) ASTM C33 – Standard Specification for Concrete Aggregates
8) ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
9) ASTM C579 – Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes

C. Society for Protective Coatings (SSPC)

1) SSPC SP 10 – Joint Surface Preparation Standard, Near White Blast Cleaning (NACE2)
1.4 Definitions

A. Epoxy Resin Binder: A two-component epoxy bonding system in low and medium viscosities used by itself as a primer or for producing epoxy concrete or mortars when mixed with aggregate.

B. Epoxy Concrete: A combination of epoxy resin binder and fine and coarse aggregate used in the repair of spalling along joints or cracks, small surface spalls or pop outs.

C. Non-Pressure Epoxy Grout: A combination of epoxy resin binder, mineral filler and a thixotropic agent used in cementing dowels in place.

D. Concrete Rehabilitation: Shall include removal and repair of deteriorated concrete up to 2 inches in depth where reinforcing steel does not need to be repaired or replaced.

E. Concrete Repair: Shall include removal and repair of deteriorated concrete in excess of 2 inches in depth where the reinforcing steel needs to be repaired or replaced.

F. Concrete Protective Coating: Shall be in accordance with Section 03931.

1.5 Measurement and Payment

A. Concrete rehabilitation will be paid for on a unit price basis as indicated in the bid schedule, unless otherwise noted.

B. Concrete repair will be paid for on a per unit basis as indicated in the bid schedule. Concrete repair will be measured based on the volume of the material applied as measured by the CONTRACTOR and verified by the OWNER based on batch weight and volume data for the approved mix, epoxy, delivery tickets and application of material records submitted by the CONTRACTOR in accordance with Paragraph 1.4. Concrete Protective Coating will be paid for as part of the lump sum payment for the contract and will not be measured separately.

C. Payment will be made at the respective unit prices, measured as specified above. The unit prices shall include the cost of all labor, materials, and the use of equipment and tools required to complete the work except for any items specified to be paid separately. The unit prices in the schedule will be used for both added and deducted work.

2. Products

2.1 Manufacturer

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Materials

A. Epoxy

1) Epoxy Resin Binder for Concrete Repairs:
(a) For horizontal surfaces, use ASTM C 881, Type III, Grade 1, Class C without mineral filler. For vertical and overhead use ASTM C 881, Type III, Grade 3, Class C with filler.

2) Non-Pressure Epoxy Grout:

(a) ASTM C 881, Type IV, Grade 2, Class C with or without mineral filler.

B. Aggregate: For material passing No. 200 sieve provide a non-plastic material composed of a minimum of 75 percent limestone dust, talc or silica inert filler. Provide dry aggregate.

1) For epoxy concrete: ASTM C 33, maximum size 1/4 inch.

C. Coating system shall conform with Section 03931 – Concrete Protective coatings

D. Infiltration Control Mix: A rapid-setting cementations product specifically formulated for leak control shall be used to stop minor water infiltration and shall be mixed and applied according to manufacturer’s recommendations and shall have the following minimum requirements:

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<th>Method</th>
<th>Time</th>
<th>Minimum</th>
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</table>

3. Execution.

3.1 Delivery, Storage, and Handling

A. Inspect materials delivered to site for damage, unload and store with a minimum of handling. Deliver epoxy resin components and aggregate materials in original sealed containers and store in dry covered areas at temperatures below 90 degrees F. Remove from job site unused mixed materials that have reached end of working or pot life.

3.2 Weather Limitations

A. Halt work when weather conditions detrimentally affect the quality of patching or bonding to concrete. Apply epoxy resin materials only when the contact surfaces are completely dry and when the atmospheric and surface temperature ranges are suitable for the specified epoxy material. Follow manufacturer's instructions for weather conditions and temperature ranges.

3.3 Equipment

A. Use a container recommended by the epoxy manufacturer as the mixing vessel. Use a power driven (air or spark-proof) propeller type blade for mixing except that hand mixing may be used for small batches. Use equipment specified by epoxy manufacturer for field mixing of aggregates and epoxy resin.
3.4 Preparation

A. Clean and prepare all interior horizontal, vertical, and overhead concrete surfaces of wet well portion of pump station. Cleaned surface must be free of all dirt, debris, oil, grease, fats, chemical contamination, salts, solvents, surface hardeners, incompatible curing compounds, and existing coatings, and form release agents, laitance and efflorescence.

B. Inspect the wet well for defective concrete by tapping with a hammer or steel rod and listening for dull or hollow sounds. In areas where tapping does not produce a solid tone, remove additional concrete until testing produces a solid tone. Make the entire cavity at least one-inch deep. Saw cut edges of cavity 1/2” to avoid feather edging. Remove dust dirt, grease, scum, waxes, chemical contaminations, salts, solvents, incompatible curing compounds and form release agents, laitance, efflorescence, and loosely bonded material resulting from cleaning. Ensure cavity surfaces are dry. Steel surfaces shall be sandblasted to a near white metal finish with 1 to 2-mil anchor profile per SSPC- SP-10.

C. Perform mapping of spalled areas of prepared wet well in accordance with Paragraph 1.2.

D. Prepare new concrete and rehabilitated concrete surfaces for coating in accordance with the coating manufacturer’s instructions.

E. Obtain written approval of the OWNER’S Inspector prior to applying any new material on existing surfaces.

3.5 Finish

A. Finish of existing concrete and epoxy concrete shall be rub finished with no voids or pits, similar to medium sandpaper (40 to 60 grit), or as required by the coating manufacturer, before applying primer for coating.

3.6 Mixing Materials

A. Make batches small enough to ensure placement before binder sets. Mix materials in accordance with manufacturer's recommendations.

3.7 Leak Repair

A. For concrete cracks with active leaks, CONTRACTOR shall cut a 1-inch deep by 1-inch wide vee-groove at location of crack and fill groove with hydraulic cement per manufacturer’s directions so that filled area is flush with existing surface.

B. Non-crack related leaks shall be plugged or repaired with an approved infiltration control mix in accordance with this Specification. The infiltration control mix shall be mixed and applied per the manufacturer’s recommendations.

3.8 Formwork

A. Formwork for epoxy concrete or grout materials shall be in accordance with Section 03300.
3.9 Placement

A. Epoxy Concrete: Prime dry cavity surfaces with epoxy primer using a stiff bristle brush. Make epoxy primer application approximately 20 mils thick. Place epoxy concrete with trowel, while primer is still tacky, and in layers not exceeding one inch thick or in accordance with manufacturer’s recommendation. Use formwork where necessary based on the thickness of material to be applied. Use vibratory floats, plates, or hand tampers to consolidate the concrete. Level each layer and screed the final surface to match the adjoining surfaces. Remove excess epoxy concrete on adjacent surfaces before the concrete hardens. Do not feather epoxy concrete out onto adjacent surfaces. Wet well surfaces shall be restored to their original dimensions, unless otherwise noted.

B. Non-Pressure Epoxy Grout

1) Cementing Dowels: Immediately prior to placing the dowel, clean hole of dust material with a high-pressure air hose. Fill hole halfway with grout. Insert dowel in hole by rotating it at least one complete turn while tapping it down. Add more grout if necessary to fill hole.

3.10 Curing

A. Cure epoxy materials in accordance with manufacturer's recommendations.

3.11 Field Quality Control

A. As soon as epoxy resin and aggregate materials are available for sampling, obtain by random selection a sample of each batch. Clearly identify samples by designated name, specification number, batch number, area of application (mapped) project contract number, intended use and quantity involved.

B. Testing shall be done in accordance with ASTM C 31. At the discretion of the OWNER’S Inspector, the OWNER may test samples provided. Test samples by an approved laboratory. If a sample fails to meet specification requirements after two tests, replace the batch represented by the samples tested and retest. Test aggregates in accordance with ASTM C 117 and ASTM C 136.

C. Inspection and Contractor Quality Control: Check each repaired area for cracks, spalls, pop outs and loss of bond between repaired area and surrounding concrete. Check each repaired area for voids by tapping with a hammer or steel rod and listening for dull or hollow sounds. Immediately repair defects. The CONTRACTOR and the OWNER’S Inspector shall inspect and certify rehabilitation of concrete procedures. Each repair shall be inspected. Each repair will require more than one inspection to certify compliance with the contract requirements. All inspections will be made in presence of the OWNER’S Inspector. The CONTRACTOR’S inspection report will certify that the work has been completed in accordance with the contract requirements. The report will explain in detail work completed to:

1) Clean or prepare surfaces to receive repairs.

2) Procedures used in the work.
3) Correction or lack of correction of deficiencies noted by the Inspector.

4) Inspection and testing of the work.

END OF SECTION
Section 03931 – Concrete Protective Coatings

1. General.

1.1 Summary

A. This section addresses the work related to furnishing all labor materials, equipment, and incidentals required to supply and install corrosion resistant coatings and waterproofing on concrete surfaces as shown on the Contract Drawings

B. Related Sections

- 01600 Materials and Equipment
- 03300 Cast-in-Place Concrete
- 03400 Precast Concrete Valve Vaults
- 03930 Concrete Rehabilitation

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division 1, General Provisions, and Section 01600 – Materials and Equipment.

B. Design Data

1) Resurfacing Materials, Epoxy Primer, Coating System, and Below Grade Exterior Waterproofing

C. Instructions

1) Resurfacing Materials, Epoxy Primer, Coating System and Below Grade Exterior Waterproofing: Surface preparation; mixing; curing; application methods, rates and thickness; and holiday detection and repairing, and safety measures.

D. Reports

1) Resurfacing Materials

   (a) Product Data Sheets

   (b) Certification that the Resurfacing Materials are compatible with the proposed coatings and primers

2) Epoxy Primer – include the following:

   (a) Viscosity

   (b) Consistency

   (c) Gel time

   (d) Absorption
(c) Shrinkage

(f) Thermal compatibility

3) Coating – Include the following:

(a) Number of coats

(b) Tensile strength

(c) Abrasion resistance

(d) Hardness

(e) Adhesive strength

4) Exterior Below Grade Waterproofing

(a) Dry Film Thickness

(b) Solids Content

(c) Theoretical Coverage Rate

(d) Dry Temperature Resistance

E. Product Experience and Test Data – Coating Systems

1) Provide documentation including project information, reference, and contact information regarding at least five similar coating applications that have been in service for five years.

2) Provide certified test data documenting compliance with Section 2.2C and applicable standards for epoxy coatings used in corrosive environments of municipal wastewater systems.

F. Certificates – Training and Qualifications

1) All personnel associated with the mixing, handling, and placing of epoxy products shall be certified for a minimum of three years by the coating manufacturer as trained, shall have a minimum of five similar successful coating applications, and shall be qualified to perform all operations in accordance with the requirements of the manufacturer and these Contract Documents. Submit training and qualification certificates for the following products:

(a) Concrete Resurfacing Material

(b) Epoxy Primer

(c) Coating System
(d) Exterior Below Grade Waterproofing

1.3 References

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The referenced publications shall be the current effective edition.

B. American Society for Testing and Materials (ASTM)

1) ASTM C 881 - Standard Specification for Epoxy-Resin-Base Bonding System for Concrete


3) ASTM D 4414 - Standard Practice for Measurement of Wet Film Thickness by Notched Gages

4) ASTM D4417 – Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

5) ASTM D4263 – Standard Guide for Metals Free Steam Deactivation of Fresh Fluid Cracking Catalysts


7) ASTM E337 – Standard Test Method for Measuring Humidity with a Psychrometer

C. National Association of Corrosion Engineers (NACE)

1) NACE SP0188 – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

2) NACE SP0288 – Inspection of Lining Application in Steel and Concrete Equipment

3) NACE SP0892 – Coatings and Linings over Concrete for Chemical Immersion and Containment Service

4) NACE TPC2 – Coatings and Linings for Immersion Service, Chapter 1: Safety, Chapter 2: Surface Preparation, Chapter 3: Curing, Chapter 4: Inspection

5) NACE 6 - Surface Preparation for Concrete

6) NACE 6D-173 – A Manual for Primer Safety

7) NACE 6F-163 – Surface Preparation of Steel or Concrete Tank Interiors
D. Society for Protective Coating (SSPC)

1) SSPC PA 3 – A Guide to Safety in Paint Application

2) SSPC SP 1 – Solvent Cleaning

3) SSPC SP 3 – Power Tool Cleaning

4) SSPC SP 5 – White Metal Blast Cleaning

5) SSPC SP 10 – Near White Blast Cleaning

6) SSPC SP 13 – Surface Preparation of Concrete

7) SSPC VIS 1 – Pictorial Surface Preparation Standards

E. International Concrete Repair Institute (ICRI)

1) ICRI 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.4 Definitions

A. Concrete Resurfacing Material: A polymer-modified cementitious material used to fill surface voids and imperfections on the concrete surfaces so that coatings can be properly applied.

B. Epoxy Primer: A two-component Polyamide based epoxy primer that adheres to masonry, metal, dry and damp concrete surfaces.

C. Coating System: Epoxy Coating System: A 100% solids epoxy coating system suitable for application on concrete surfaces and having resistance to deterioration caused by exposure to the corrosive gasses and liquids typical of a municipal sewer system. The system shall be suitable for application on horizontal, vertical, and overhead surfaces.

D. Exterior Below Grade Waterproofing: Brush, roller, or spray applied-single component waterproofing for concrete surfaces.

1.5 Delivery, Storage, and Handling

A. Inspect materials delivered to site for damage; unload and store with a minimum of handling. Remove from job site unused mixed materials that have reached end of working or pot life. All materials shall be stored and handled in accordance with the respective material safety data sheets and the manufacturer’s written instructions.

B. Deliver and store epoxy resin components and products in original sealed containers and store in dry covered areas at temperatures between 60-and 90-degrees F. Store in ventilated area, and as required by manufacturer’s instructions. Inspect to verify acceptability.
C. Container label shall include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

D. Store materials at a minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F

1.6 Environmental Requirements

A. Apply all coating materials only when the contact surfaces are completely dry and when the atmospheric and surface temperature ranges are suitable for the specified coating material. Follow manufacturer’s instructions for weather conditions and temperature ranges.

B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the product manufacturer.

1.7 Equipment

A. Use a container recommended by the epoxy manufacturer as the mixing vessel. Use a power driven (air or spark proof) propeller type blade for mixing epoxy except that hand mixing may be used for small batches. Use equipment specified by the manufacturer for field mixing and application of the coatings system.

2. Products

2.1 Manufacturers

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Materials

A. Concrete Resurfacing Material

1) When required or recommended by the coating manufacturer, apply a polymer modified cementitious material to fill surface voids and imperfections on the concrete surfaces. The material type and application shall be in strict conformance with the coating manufacturer’s instructions. The concrete resurfacing material shall be compatible with the primer and the coating.

B. Epoxy Primer

1) When required or recommended by the coating manufacturer, or Contract Documents, apply an epoxy primer to the concrete surfaces receiving the coating. The primer type and application shall be in strict conformance with the coating manufacturer’s instructions. The primer shall be compatible with the concrete resurfacing material and the coating.
C. Epoxy Coating

1) Coating shall be 100% solids epoxy system specifically resistant to corrosive wastewater environments. The coating shall be capable of withstanding, without detrimental effect, continuous contact with or immersion in 10% sulfuric acid solution, moisture, turbulent sewage flow, and temperatures ranging from 20 degrees F. to 120 degrees F.

D. Exterior Below Grade Waterproofing

1) Apply below grade waterproofing to all vertical concrete surfaces permanently exposed to soil or groundwater.

3. Execution

3.1 Preparation

A. General

1) Clean and prepare all interior horizontal, vertical and overhead concrete surfaces of wet well portion of pump station in accordance with the coating manufacturer’s requirements. Use abrasive methods such as sand or water blasting as required by the coating manufacturer. Do not use methods such as manual or power chipping.

2) Cleaned surface must be free of all dirt, debris, oil, grease, fats, chemical contamination, salts, solvents, surface hardeners, incompatible curing compounds and form release agents, laitance and efflorescence.

3) A 28-day minimum cure time is required for all new concrete surfaces before any coating or waterproofing components may be applied.

B. Repair and treat surface imperfections such as voids and cracks according to the manufacturer’s recommendation’s and requirements.

C. Treat joints in the concrete structure according the manufacturer’s recommendations and requirements.

D. Coating

1) Prepare new, rehabilitated, and existing concrete surfaces for coating in accordance with the coating manufacturer’s written instructions.

E. Obtain written approval of the OWNER prior to applying any new material on existing surfaces.

3.2 Placement

A. Primer Coating

1) Prime concrete surfaces to be coated in accordance with manufacturer’s
recommendation. Allow the primer to set firm to the touch before applying coating.

2) Prevent the primed surfaces from becoming contaminated. Clean primed surfaces, which become contaminated, in accordance with manufacturer’s recommendations.

3) Test for pin-holes in prime coating using high voltage holiday detection equipment to ensure a pin-hole free lining. Repair pin-holes in accordance with the manufacturer’s recommendations and retest to ensure the prime coat is free of pinholes prior to receiving the final coat.

(a) Obtain written approval of the spark test by an independent testing laboratory, approved by the OWNER, prior to applying the final coat over the primer.

B. Final Coating

1) The CONTRACTOR shall use equipment as recommended by the manufacturer for the application of the coating. The coating system shall be applied to a thickness required by the manufacturer and measured with a wet film thickness gauge.

2) Test for pinholes in coating using high voltage holiday detection equipment to ensure a pin-hole free lining. Repair pin-holes in accordance with manufacturer’s recommendations and retest to ensure the finish coat is free of pin-holes.

3) The minimum thickness of the coating system (prime and finish coat) shall be 125 mils.

4) All exposed new, rehabilitated, and existing concrete surfaces within the wet well shall be coated.

5) Have the OWNER’s Inspector sign and approve the final spark test and wet film thickness and include this approval with monthly payment requests.

C. Below Grade Exterior Waterproofing

1) The CONTRACTOR shall be responsible to coordinate and provide all required substrate preparation of the pump station as required for the satisfactory installation of the coating system.

2) Apply products in accordance with manufacturer's instructions.

3) Do not apply finishes to surfaces that are not dry.

4) Apply each coat to uniform finish. Number and thickness of coats shall be in accordance with manufacturer’s recommendations.

5) Brush, roll-on or spray. Spray shall be induction type pump with 20 to 30 psi air pressure on liquid and 50 psi minimum on the gauge.
6) Thinners: Not allowed.

7) Allow applied coat to dry before next coat is applied. Drying time shall be in accordance with manufacturer’s recommendations.

3.3 Curing

A. Cure coating materials in accordance with the manufacturer’s recommendations.

3.4 Field Quality Control

A. Testing

1) Thickness: During the coating application, a wet film thickness gage, meeting ASTM D 4414 shall be used to ensure a monolithic coating, adequate and uniform thickness during application.

2) Holiday Detection: After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment in accordance with the manufacturer’s recommendations and NACE SP0188. Holiday detection results shall only be valid if the OWNER’S Inspector witnesses all testing and co-signs the inspection report to indicate concurrence with the report’s contents.

3) Marking of Holidays and Repair: Holidays are to be marked on the lining using felt tipped pens or other markers approved by the lining material manufacturer. Holidays are to be repaired in strict accordance with the lining manufacturer’s recommendation and at no additional cost to the OWNER. Holiday detection is to be repeated only over the coating repair locations.

4) Visual Inspection: A final visual inspection shall be made by the OWNER and the manufacturer’s representative. Any deficiencies in the finished coating shall be marked and repaired according to the manufacturer’s recommendations.

B. Manufacturer Representative

1) Epoxy Coating manufacturer’s representative shall be on-site to inspect the completed surface preparation and for final inspection. Holiday detection results shall only be valid if the manufacturer’s representative witnesses all testing and co-signs the inspection report to indicate concurrence with the report’s contents.

END OF SECTION
Section 04200 – Cavity Wall Masonry System

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing building walls, including concrete masonry backup wythe, single wythe concrete masonry walls, brick veneer, mortar mix design, placement procedures, reinforcement, anchorage, and accessories.

B. Related Sections

01600 Materials and Equipment
05501 Anchor Bolts and Anchors
07620 Sheet Metal Flashing and Trim
07900 Joint Sealants
08100 Steel Doors and Frames
09900 Painting

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Concrete Masonry Unit Product Data

C. Brick Product Data

D. Mortar Product Data

E. Reinforcement Product Data

F. Wire Ties and Anchors Product Data

G. Weeps Product Data

H. Cleaning Solution Product Data

I. Cavity Drainage Material

J. Grout Mix Design

1.3 Quality Assurance

A. Perform Work in accordance with ACI 530 and ACI 530.1.

B. Obtain Masonry units from a single manufacturer for each type required.

1.4 References

A. The publications listed below form a part of this specification to the extent referenced.
The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. American Concrete Institute International (ACI)

1) ACI 318 Building Code Requirements for Structural Concrete and Commentary
2) ACI 530/530.1 Building Code Requirements and Specification for Masonry Structures and Related Commentaries

C. ASTM International (ASTM)

1) ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4) ASTM C1072 Standard Test Method for Measurement of Masonry Flexural Bond Strength
5) ASTM C144 Standard Specification for Aggregate for Masonry Mortar
7) ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes
8) ASTM C216 – Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
9) ASTM C270 Standard Specification for Mortar for Unit Masonry
10) ASTM C476 Standard Specification for Grout for Masonry
12) ASTM C780 Standard Test Method for Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
13) ASTM C90 – Standard Specification for Loadbearing Concrete Masonry Units
14) ASTM C91/C91M Standard Specification for Masonry Cement
15) ASTM C94/C94M Standard Specification for Ready-Mixed Concrete
1.5 Qualifications
A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years’ experience.

1.6 Regulatory Requirements
A. Conform to applicable requirements of ASTM E119 for fire rated masonry construction where indicated on the Contract Drawings

1.7 Environmental Requirements
A. Cold Weather Requirements: Comply with requirements in ACI 530.1.
B. Hot Weather Requirements: Comply with requirements in ACI 530.1.

1.8 Coordination
A. Coordinate the masonry work with installation of louvers, anchors, and door frames.

1.9 Delivery, Storage, and Handling of Masonry
A. Deliver all units on tight pallets. Broken pallets will be rejected.
B. Confirm color of material conforms to sample wall.
C. Do not install broken units.
D. Accept pre-faced units on site. Inspect for damage.
E. Store cement materials, aggregates, and metal accessories by covering them and storing them elevated off the ground.

2. Products
2.1 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Concrete Masonry Units
A. Backup & Interior Hollow Load Bearing Block Units (CMU): ASTM C90; normal weight. With a minimum compressive strength of 800 psi over the average gross area or 2000 psi over the net area.
B. Reject defective concrete masonry units with cracks and chips when unit faces are exposed as finished surfaces. Faces with cracks and chips may be used in concealed locations.
C. Size and Shape: Nominal modular size of 8 x 8 x 16 inches. Provide special units for 90 degree outside corners, bond beams, lintels, jambs, chimney, and other special shapes called for on the Contract Drawings.
2.3 Brick
   A. Face brick, used for exposed exterior surfaces, shall meet requirements of ASTM C 216, Grade SW, Modular Size, 3-1/2 by 2-1/4 by 7-5/8 inches, full body brick.

2.4 Reinforcement
   A. Ladder type welded wire reinforcing wires at 16 inches on center with three longitudinal wires spaced for CMU faces and center of brick wythe the cross wires shall not be spaced greater than 16 inches on centers, either horizontally or vertically.
   B. Reinforcing Steel: ASTM A615/A615 M, 60 ksi yield grade, deformed billet bars, uncoated finish.

2.5 Wire Ties and Anchors
   A. Wire shall be hot-dipped galvanized wire conforming with ASTM A1064/A1064M with ASTM A153/A153M coating, Class B-2.
   B. Sheet shall be galvanized steel sheet conforming with ASTM A653/A653M, commercial steel, G60 zinc coating.
   C. Ties and anchors shall extend a minimum of 1-1/2-inches into veneers with not less than 5/8-inch cover at the exterior face.

2.6 Flashing: As specified in 07620.

2.7 Accessories
   A. Joint Sealer: As specified in 07900.
   B. Weeps: Open head joints with PVC sleeve inserts. 32" o.c. above all lintels and solid surfaces and as noted on the Contract Drawings.
   C. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.
   D. Cavity Drainage Material (Mortar Nets): Dovetail shape strips full depth of the cavity; 10-inches tall with 7-inch dovetail notches that prevent mortar droppings from clogging weeps; consisting of polymer strands configured as a draining mesh.

2.8 Mortar
   A. Mortar: Shall conform to one of the following:
      1) Field Mixed: ASTM C 270 Proportion Specification, 1 part cement (ASTM C 150 and ASTM C 91, Type II) 1/4 part by volume lime (ASTM C 207, not less than 2-1/4 nor more than 3 times the sum of volumes of cement and lime used, (sand) aggregate (ASTM C144); Type S, except Type N or tuck pointing.
      2) Preblended dry mortar mix consisting of measured quantities of ingredients by weight to accurate proportions, thoroughly blended before delivery. ASTM C 270 Property Specification; Type S, except Type N for tuck pointing.
B. Maximum air content: 12%

C. Calcium Chloride additive will not be permitted.

D. Mortar Color for Exterior Brick Veneer to be Buff as approved by the OWNER.

E. Thoroughly mix mortar ingredients in accordance with ASTM C270 Proportion Specification in quantities needed for immediate use.

F. Maintain sand uniformly damp immediately before the mixing process.

G. Do not use anti-freeze compounds to lower the freezing point of mortar.

H. If water is lost by evaporation, re-temper only within two hours of mixing.

I. Use mortar within two hours after mixing at temperatures above 90 degrees F or two-and-one-half hours at temperatures under 50 degrees F.

2.9 Grout

A. Grout shall conform to ASTM C476.

B. Bond Beams, Engineered Masonry and Lintels, Grouted Cells for Vertical Reinforcement: 3,000 psi strength minimum at 28 days; 8 inches slump in accordance with ASTM C143/C143M; mixed in accordance with ACI 318. Pre-mixed type in accordance with ASTM C91 with #8 aggregate size.

C. Mix grout in accordance with ASTM C94.

D. Aggregate shall conform to ASTM C404.

2.10 Water: Potable. PH to be neutral.

3. Execution

3.1 Examination

A. Verify that field conditions are acceptable and are ready to receive work.

B. Verify items provided by other sections of work are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.2 Preparation

A. Direct and coordinate placement of metal anchors supplied under other sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
3.3 Coursing

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints with uniform thickness.

C. Concrete Masonry Units
   1) Bond: Running, shall conform to ASTM C1072
   2) Interior Mortar Joints: Concave.
   3) Exterior Mortar Joints: Concave.

D. Brick Units
   1) Bond: Flemish.
   2) Interior Mortar Joints: Concave.
   3) Exterior Mortar Joints: Concave.

3.4 Placing and Bonding

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work. The end of the structural block shall be "buttered" with sufficient mortar to fill the end joint. Mortar beds shall be spread smooth or only slightly furrowed. The vertical longitudinal joint in solid brick walls shall be completely filled by "parging" or by "shoving". The slushing of joints after laying should not be necessary and will not be permitted. All structural brick having absorption rates, as determined by tests according to ASTM C67, exceeding 30 grams / 30 square inches shall be wetted so that the rate of absorption when laid does not exceed that amount.

B. Lay hollow masonry units with face shell bedding on head and bed joints.

C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

D. Remove excess mortar as work progresses.

E. Interlock intersections and external corners.

F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Do not install masonry units with broken corners or edges.

3.5 Weeps

A. Install weeps in veneer at 32 inches o.c. horizontally above through-wall flashing, above shelf angles and lintels, and at bottom of walls.
B. Place weeps one course above slab on wet well side of the structure.

3.6 Cavity Wall
A. Install cavity drainage material (mortar nets) at the bottom of all cavity spaces, at lintels and other horizontal interruptions of the cavity to prevent the accumulation of mortar droppings in the cavity air space and plugging weeps.

3.7 Reinforcement and Anchorage
A. Install horizontal joint reinforcement 16 inches (max) o.c.
B. Place masonry joint reinforcement in first horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
C. Place joint reinforcement continuous in first joint below top of walls.
D. Lap joint reinforcement ends minimum 6 inches.
E. Reinforce joint corners and intersections with strap anchors at 16 inches o.c.
F. The reinforced cells of concrete masonry walls shall be filled with grout. The grout shall be vibrated to ensure that cells are completely filled. All walls shall be reinforced as follows:
   1) Walls: Place vertical reinforcing bars at the horizontal spacing as noted on the Contract Drawings.
   2) Openings: Two cells on each side of the opening shall be reinforced with #5 reinforcing bar or as noted on the Contract Drawings.
   3) Wall Corners: Corner cell and the adjacent cell on each side of the corners shall be reinforced with #5 bars
   4) Bond Beam: As shown on the Contract Drawings.
G. The vertical wall reinforcing shall provide a continuous load path from the foundation into the continuous bond beam at the top of the wall. The wall reinforcing shall:
   1) Splice with foundation dowels at the horizontal spacing shown on Contract Drawings.
   2) Terminate in the top of wall bond beam with a 90-degree hook, which captures the top reinforcing bars in the bond beam.
   3) Lap splice length shall be a minimum of 24 bar diameters

3.8 Masonry Flashing
A. Extend flashing horizontally at foundation walls, above ledge or shelf angles and lintels, and at bottom of walls.
B. Turn flashing up a minimum of 8-inches and bed into mortar joint of masonry.

C. Lap end joints a minimum of 6-inches and seal watertight.

D. Turn flashing, fold, and seal at corners, bends, and interruptions.

3.9 Lintels

A. Unless noted otherwise lintels shall be formed using 8-inch masonry lintel blocks. The lintels shall be filled with grout as specified herein and shall be reinforced as shown on the Contract Drawings. The ends of the reinforcing bars shall have a standard hook. The lintels shall bear a minimum of 8 inches on each support wall. The walls shall be filled with grout for two cells each side of the opening and shall have a continuous reinforcing bar, which is anchored in the foundation and anchored into the bond beam at the top of the wall.

3.10 Grouted Components

A. Reinforce bond beam with reinforcing bars as noted on the Contract Drawings.

B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

C. Place and consolidate grout fill without displacing reinforcing.

D. Provide reinforcing bar and fill masonry cores with grout for a minimum of 8 inches above and below each side of opening unless shown otherwise on the Contract Drawings.

E. Provide additional reinforcing in accordance with Paragraph 3.7 or as shown on the Contract Drawings.

3.11 Built-In Work

A. As work progresses, install built-in doors, jack arches, soldier courses, louver frames, anchor bolts, plates, and other items to be built into the work.

B. Install built-in items plumb and level.

C. Bed anchors of door and frames in adjacent mortar joints. Fill frame voids solid with grout.

D. Do not build in organic materials subject to deterioration.

3.12 Tolerances (non-cumulative)

A. Maximum Variation from Unit to Adjacent Unit: 1/32 inch.

B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

C. Maximum Variation from Plumb: 1/4 inch in each story; 1/2 inch in two stories or
more.

D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.

F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.13 Cutting and Fitting

A. Cut and fit for pipes, conduit, and sleeves. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

C. The CONTRACTOR shall set all pipes, drains, sleeves, hangars, anchor bolts, frames, louvers, flashings and other items to be installed in masonry, as the work proceeds. No "boxing out" or cutting of finished work will be permitted. Built-in items shall be of the size and type shown and shall be located accurately in the position shown. The outside joints at the perimeter of exterior frames shall be caulked with an approved material as required or indicated.

3.14 Pointing

A. When the work is completed, all holes or defective mortar joints in the exposed masonry shall be pointed, or where necessary, cut out and repointed. Exposed surfaces shall be protected against staining, and excess mortar shall be wiped off the surface as the work progresses.

3.15 Cleaning

A. While laying the brick, good workmanship and job housekeeping practices shall be used to minimize the need for cleaning the brick. Protect the base of the wall from mud splashes and mortar droppings; protect the wall by setting scaffolds so that mortar is not deflected onto the wall. At the end of each day, set the scaffolding boards so that they do not deflect rainfall onto newly laid masonry.

1) The bricklaying technique shall be such that mortar does not run down the face of the wall, or smear the mortar onto the brick face.

2) After the joints are tooled, cut off mortar tailings with the trowel, and brush excess mortar burrs and dust from the face of brick. Do not bag or sack the wall, but use a bricklayer's brush made with medium soft hair.

B. Remove all large mortar particles with a hardwood scraper.

C. If, after using the above outlined techniques, additional cleaning of the walls is found necessary, allow the walls to cure one month prior to initiating further cleaning processes.
D. Saturate the wall with clean water. The wall shall be thoroughly saturated prior to and at the time the cleaning solution is applied.

E. Clean the wall only with an approved cleaning solution applied with a brush, starting at the top of the wall. The concentration, method of application of the cleaning solution, and method of scraping shall be as outlined on the container by the manufacturer.

F. High pressure water and sandblasting shall not be used for cleaning except with the recommendation of the brick manufacturer, and the written approval of the OWNER.

G. Immediately after cleaning a small area, the wall shall be rinsed thoroughly with water.

H. Protect adjacent surfaces and materials during brick cleaning operations.

I. After the walls are cleaned, take necessary precautions to ensure that other contractors and subcontractors do not damage or soil the walls. Mud protection around the base of walls shall be left in place until the final grading work is done.

J. Use non-metallic tools in cleaning operations.

3.16 Protection of Finished Work

A. Without damaging completed work, provide protective boards at exposed external corners, which may be damaged by construction activities.

3.17 Field Quality Control

A. Test and evaluate mortar in accordance with ASTM C780.

B. Test and evaluate grout in accordance with ASTM C1019.

END OF SECTION
Section 05500 – Miscellaneous Metal Items

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing metal fabrications including items made from iron, steel or aluminum shapes, plates, bars, strips, tubes, pipes and castings, which are not specified elsewhere.

B. Related Sections

- 01600 Materials and Equipment
- 05501 Anchor Bolts and Anchors
- 05510 Metal Stairs
- 05520 Handrails and Railings
- 05715 Fabricated Spiral Stairs
- 14630 Trolley and Runway Beam
- 15062 Interior Pipe, Fittings, Valves and Specialties

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Welding Certificates.

C. Submit manufacturer's specifications, anchor details, and installation instructions for products used in miscellaneous metal fabrications, including paint products and grout.

D. Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include plans, elevations and details of sections and connections.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. Aluminum Association (AA)

1) Aluminum Design Manual

2) AA DAF45 – Designation System for Aluminum Finishes

C. American Welding Society

1) AWS D1.1/D1.1M – Structural Welding Code – Steel

2) AWS D1.2/D1.2M – Structural Welding Code – Aluminum
3) AWS D1.6/D1.6M – Structural Welding Code – Stainless Steel

D. ASTM International (ASTM)

1) ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality

2) ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3) ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4) ASTM A193/A193M – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

5) ASTM A194/A194M – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both


7) ASTM A276/A276M – Standard Specification for Stainless Steel Bars and Shapes

8) ASTM A36/A36M – Standard Specification for Carbon Structural Steel


10) ASTM A500/A500M – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

11) ASTM A501/A501M – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

12) ASTM A780/A780M – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings


14) ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate


E. National Association of Architectural Metal Manufacturers (NAAMM)

1) NAAMM MBG 531 – Metal Bar Grating Manual

F. The Society for Protective Coatings (SSPC)

1) SSPC SP 3 – Surface Preparation Specification No. 3 Power Tool Cleaning

2) SSPC SP 6/NACE No.3 – Joint Surface Preparation Standard SSPC-6/NACE No.3 Commercial Blast Cleaning

G. Occupational Safety and Health Administration (OSHA)

1) Standard 29 CFR 1910.23 – Ladders


1.4 Qualification of Welders

A. Qualify welders in accordance with AWS D1.1/D1.1M, AWS D1.2/D1.2M and AWS D1.6/D1.6M. Use procedures, materials, and equipment of the type required for the work. Welds shall be made only by welders, tackers, and welding operators who are currently qualified by tests as prescribed in the Structural Welding Code, AWS D1.1/D1.1M, AWS D1.2/D1.2M and AWS D1.6/D1.6M of the American Welding Society to perform the type of work required.

2. Products

2.1 Aluminum Fabrications

A. Materials

1) Plate and Sheet ASTM B209 6061-T6 T6510 Alloy

2) Extruded Shapes ASTM B221 6061-T6 T6510 Alloy

3) Castings ASTM B26/B26M 443.0-F Alloy

B. Structural aluminum members shall be fabricated of 6061-T6 aluminum.

C. Finishes other than Grating: As Fabricated AA-M12.

2.2 Grating

A. Grating shall be aluminum bar grating as shown on the Contract Drawings. The bearing bars and cross bars shall be 6061-T6 aluminum.
B. Grating sections shall be removable and the individual sections shall be limited to a maximum weight of 50 pounds.

C. Aluminum Bar Gratings: Comply with NAAMM MBG 531; ASTM B221, alloy 6061-T6 for bearing and cross bars.

D. Grating Finish: Clear anodic AAMA 611, AA-M12C22A41, Class I.

E. Grating shall have 3/16” thick minimum bearing bars spaced at 1 3/16” on center and have cross bars spaced at 4” on center.

F. All grating panels shall be banded with a bar the same size as the bearing bars.

G. Grating Design Criteria:

1) Provide grating meeting the design live load of adjacent floor area but not less than a uniform live load of 100 psf or a concentrated load of 300 pounds over a 12 inch area at the center or span unless shown on the Contract Drawings, whichever produces that greatest stresses.

2) Grating shall not exceed the fabricator's maximum recommended span and must meet or exceed the following load and deflection criteria for the maximum span length at the opening being covered by the grating.

(a) The grating shall produce a deflection of 1/360 of the span or less under the required uniform live load on the maximum span.

(b) The grating shall produce a deflection of 1/360 of the span or less under a concentrated live load of 300 lbs applied at the mid-point of the maximum span.

H. Openings 2-in or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing bars or cross bars shall be welded to the banding bar.

2.3 Ferrous Metals

A. Metal Surfaces, General: For fabrication of miscellaneous metal work, which will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled names and roughness.

B. Steel Plates, Shapes and Bars: ASTM A36/A36M. (Hot Dipped Galvanized - 2 Oz. per SF)

C. Steel Tubing: Cold-formed, ASTM A500/A500M; or hot-rolled, ASTM A501.


2.4 Loose Steel Lintels

A. Fabricate loose structural steel lintels from steel angles and shapes of size indicated
for openings and recesses in masonry walls and partitions and locations indicated.

B. Size loose lintels for equal bearing of 1 inch per foot of clear span but not less than 8 inches bearing at each side of openings, unless otherwise indicated. Minimum size shall be 5" X 3-1/2" X 5/16" for each 4" thickness of masonry supported.

C. Galvanize loose steel lintels, shipped with galvanizing.

2.5 Fasteners

A. Provide Type 316 stainless steel fasteners for all exterior and interior work unless otherwise shown or specified.

B. Bolts - ASTM F593 for stainless steel bolts Nuts - ASTM F594 for stainless steel nuts

C. Fasteners for Aluminum Gratings: Fasteners shall be sized by grating manufacturer. Use Type 316 stainless steel fasteners.

2.6 Galvanizing

A. Shapes: ASTM A-123; Coating Grade 85 (2.0 oz/sf)

B. Hardware: ASTM A-153 2.0 oz/sf.

2.7 Stainless Steel

A. Stainless Shapes: ASTM A276; TYPE 316 L

B. Stainless Plate: ASTM A240/A240M or ASTM A666; TYPE 316 L

2.8 Ladders

A. Fabricate vertical ladders conforming to 29 CFR 1910.23. Use 2-1/2 by 3/4-inch aluminum rails for stringers. Rungs shall be 1-inch square aluminum rods welded to stringers. Rungs shall be a minimum width of 16 inches and have a maximum vertical spacing of 12 inches, unless otherwise shown on the Contract Drawings. Install ladders so that the distance from the center of the rungs to the finished wall surface will not be less than 7 inches. Provide heavy aluminum clips angles welded to the stringer and drilled for expansion anchors. Spacing for clip angles shall not exceed 48 inches on centers.

2.9 Ladder Cages

A. Conform to 29 CFR 1910.29. Fabricate 2 by ¼ inch horizontal bands and 1 ½ by 3/16 inch vertical bars, unless otherwise shown on the Contract Drawings. Provide attachments for fastening bands to the side rails of ladders or directly to the structure. Provide and fasten vertical bars on the inside of the horizontal bands. Extend cages as shown on the Contract Drawings, but not less than 27 inches or more than 28 inches from the centerline of the rungs, excluding the flare at the bottom of the cage, and not less than 27 inches in width. Clear the inside of the cage of projections.
3. **Execution.**

3.1 **Field Measurements**

A. Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.2 **Fabrication, General**

A. Workmanship: Use materials of size and thickness indicated, or if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use the type of materials indicated or specified for various components of work.

B. Aluminum fabrication shall be in conformance with the Aluminum Design Manual.

C. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners whenever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flathead (countersunk) screws or bolts.

E. Provide for anchorage of type indicated, coordinated with supported structure. Fabricate and space anchoring devices to provide adequate support for intended use.

F. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

G. Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

H. Surface Preparation: Prepare ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications, unless otherwise specified.

1) Exterior (SSPC Zone 1B): SSPC-SP6/NACE No. 3 "Commercial Blast Cleaning".

2) Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning".

I. Provide miscellaneous steel framing and supports, which are not a part of structural
steel framework, as required to complete work.

3.3 Shop Assembly

A. Preassemble items in shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and for shipping and handling limitations. Clearly mark units for reassembly and coordinated of installation.

3.4 Touch Up Painting

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paints, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. All aluminum surfaces to come in contact with concrete or dissimilar metals shall be coated with two coats of aluminum pigmented bituminous paint.

C. Repair any damaged surfaces with galvanizing repair method and paint conforming to ASTM A780 or by application of stick or thick paste material specifically designed for repair of galvanizing as approved by the OWNER.

END OF SECTION
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing anchor bolts in concrete and masonry, and anchors, including expansion, sleeve and adhesive type.

B. **Related Sections**

01600 Materials and Equipment
03300 Cast-in-Place Concrete
03400 Precast Concrete Valve Vaults
04200 Cavity Wall Masonry System
05500 Miscellaneous Metal Items
05510 Metal Stairs
05520 Handrails and Railings
05715 Fabricated Spiral Stairs

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. **American Society for Testing and Materials (ASTM)**

1) ASTM A36 – Standard Specification for Carbon Structural Steel

2) ASTM A153 – Standard Specification for Zinc Coating (Hot Dipped) on Iron and Steel Hardware

3) ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength


5) ASTM C881 – Standard Specification for Epoxy -Resin-Based Bonding Systems for Concrete

7) ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength

C. U.S. Federal Specifications (FF)

1) FF-S-325 – Federal Specification: Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

2. Products

2.1 Anchor Bolts Cast In Concrete

A. Comply with ASTM A307 for carbon steel, and ASTM F593, Type 316 for stainless steel anchor bolts.

B. 6-inch minimum hook.

2.2 Anchors

A. General Requirements:

1) Anchors exposed to weather, in contact with aluminum components, or in submerged conditions: Type 316 stainless steel.

2) Anchors for all other conditions: Zinc plated; ASTM B633.

3) Anchors as required by Contract Drawings.

B. Expansion Anchors:

1) Comply with Federal Specification FF-S-325 Group II, Type 4, Class 1 forExternally threaded wedge expansion bolt anchors

2) Minimum Embedment: 6 inches, unless otherwise indicated.

C. Sleeve Anchors:

1) Comply with Federal Specification FF-S-325 Group II, Type 3, Class 3 for Tubular expansion shield anchors with a cone expander integral with the stud.

D. Adhesive Anchors:

1) Adhesive:

(a) Two component structural epoxy.

(b) Comply with ASTM C881.

2) Screen Tubes:

(a) Use with hollow base materials.
(b) Stainless steel or plastic screen.

3) Anchor: All-thread stainless steel.

4) Minimum Embedment: 4 inches unless otherwise indicated.

3. **Execution.**

3.1 Installation

A. Comply with manufacturer’s instructions.

B. Obtain approval from OWNER’S Representative of all drilled holes for anchor installation prior to installing anchors.

3.2 Anchor Bolts Cast In Concrete

A. Use galvanized carbon steel, except where stainless steel is indicated.

3.3 Anchors

A. Use expansion anchors in pre-cast or cast-in-place concrete outside the wet well.

B. Use sleeve anchors in masonry work.

C. Use adhesive anchors for all attachments to concrete in the wet well and where indicated by the Contract Drawings.

END OF SECTION
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing metal fabrications including aluminum alloy 6016-T6, stair frame of structural sections, with open risers and stair treads and landings with raised safety tread.

B. **Related Sections**

   01600 Materials and Equipment
   01650 Starting of System
   05500 Miscellaneous Metal Items
   05501 Anchor Bolts and Anchors
   05520 Handrails and Railings

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. For installed products indicated to comply with design loads, include structural analysis data, plans and details signed and sealed by the qualified professional engineer responsible for their preparation licensed to practice in the Commonwealth of Virginia.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. **American Welding Society (AWS)**

   1) AWS D1.2/D1.2M – Structural Welding Code – Aluminum

C. **ASTM International (ASTM)**

   1) ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate


   4) ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

D. National Association of Architectural Metal Manufacturers (NAAMM)

1) NAAMM MBG 531 – Metal Bar Grating Manual

2) NAAMM AMP 500 – Metal Finishes Manual

1.4 Design Requirements

A. Fabricated stair assembly to support a uniform live load of 100 lbs/sq ft with deflection of stringer or landing framing not to exceed 1/360 of span or 0.25-inch, whichever is less.

B. Fabricate stair treads to support a uniform live load of 100 lbs/sq ft and a concentrated live load of 300 pounds applied at the center of the tread, with deflection not to exceed 1/360 of span or 0.25-inch, whichever is less.

C. The design and drawings for the stairs shall be prepared and sealed by a professional engineer licensed in the Commonwealth of Virginia.

2. Products

2.1 Materials


C. Aluminum Plate and Sheets: ASTM B209; 6061-T6.

D. Stainless Steel Bolts, Nuts, and Washers: ASTM F593 hex-head bolts; ASTM F594, Grade 3 hex nuts; and flat washers, Alloy Group 2. Type 316L.

E. Anchors: In accordance with Section 05501.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; consistent with design of stair structure.

G. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.2 Components

A. Stairs: Aluminum alloy 6061-T6 with raised safety tread.

3. Execution

3.1 Preparation

A. Supply items required to be cast into concrete and/or embedded in masonry with setting templates.
3.2 Fabrication – General

A. Fit and shop assemble components in largest practical sections for delivery to site.
B. Fabricate components with joints tightly fitted and secured.
C. Continuously seal joined pieces by continuous welds.
D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
E. Exposed Mechanical Fastenings: Flush countersunk screws to bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
G. Accurately form components required for anchorage of stairs and landings to each other and to building structure.
H. Fabricate aluminum members in accordance with the Aluminum Association.

3.3 Fabrication – Stairs and Landings

A. Fabricate stairs and landings with risers and treads of all aluminum construction, ready to be installed on center support column.
B. Form treads with minimum 3/16” aluminum plate.
C. Form landings with minimum 3/16” aluminum plate. Reinforce underside with angles as required to attain design load requirements.
D. Form landings same as treads. Reinforce underside with angles to attain design load requirements.

3.4 Finishes

A. Provide as-fabricated finish; AA-M12, per NAAMM AMP 500.

3.5 Installation

A. Install components plumb and level, accurately fitted, free from distortion or defects.
B. Provide anchors, and structural members required for connecting stairs to structure.
C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
D. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
E. Obtain approval from the OWNER prior to site cutting or creating adjustments not scheduled.

END OF SECTION
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing metal fabrications including handrails, posts, and fittings; toe plates and chain.

B. **Related Sections**

- 01600 Materials and Equipment
- 01650 Starting of System
- 05500 Miscellaneous Metal Items
- 05501 Anchor Bolts and Anchors
- 05510 Metal Stairs
- 05715 Fabricated Spiral Stairs

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Include plans showing location of handrail required for the Project with all necessary dimensions, and detail drawings showing standard handrail elevations, typical connections, and anchoring systems.

2) Provide certified test results showing design requirements compliance.

3) **Test Data:** Base assembly test results.

4) For installed products indicated to comply with design loads, include structural analysis data, plans and details signed and sealed by the qualified professional engineer responsible for their preparation licensed to practice in the Commonwealth of Virginia.

5) **Welding Certificates**

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. **ASTM International (ASTM)**

1) ASTM A304 – Standard Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements

2) ASTM A484 – Standard Specification for General Requirements for Stainless
Steel Bars, Billets, and Forgings

3) **ASTM B209** – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

4) **ASTM B221** – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

5) **ASTM B241** – Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

6) **ASTM B429** – Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

7) **ASTM E488** – Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements


9) **ASTM F593** – Standard Specifications for Stainless Steel Nuts

C. **Occupational Safety and Health Administration (OSHA)**

1) **OSHA 1910.29** – Fall Protection Systems and Falling Object Protection – Criteria and Practices

D. **National Association of Architectural Metal Manufacturers (NAAMM)**


1.4 **Design Requirements**

A. Railing assembly, handrails, guards and attachments shall be designated to resist the loads herein specified:

1) A load of 50 pounds per linear foot applied in any direction at the top rail and transfer this load through the supports to the structure.

2) Handrail assemblies and guards shall be able to resist a single concentrated load of 200 pounds applied in any direction at any point along the top, and have attachment devices and supports to transfer this loading to appropriate structural elements of the supporting structure. This load need not to be assembled to act concurrently with the loads specified above.

3) Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot, including openings and space between rails. Reactions due to this loading are not required to be superimposed with those above.
B. Posts.

1) Single un-spliced length.

2) Spacing: Maximum 5’-0” center to center.

C. Rails:

1) Top Rail: Continuous wherever possible, attached to a minimum of three posts.

2) Lower Rails: Single un-spliced length between posts.

3) Handrails

   (a) Height measured above stair tread nosings or finish surfaces shall be uniform, not less than 34 inches and not more than 38 inches.

   (b) Handrails with a circular cross section shall have an outside diameter of at least 1.25 inches and not greater than 2 inches or shall provide equivalent graspability.

   (c) Hand gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

   (d) Handrails shall return to a wall, guard or the walking surface or shall be continuous to the rail of an adjacent stair flight or ramp run.

   (e) Clear space between a handrail and a wall or other surface shall be a minimum of 1.5 inches.

4) Guards

   (a) Guards shall be located along open-sided walking surfaces, mezzanines, equipment platforms, stairways, ramps and landings that are located more than 30 inches above the floor or grade below.

   (b) Guards shall form a protective barrier not less than 42 inches high, measured vertically above the leading edge of the tread or adjacent walking surface.

   (c) Horizontal intermediate rails shall not permit a sphere with a diameter of 4 inches to pass through any openings.

D. Comply with OSHA and state and local codes.

E. All railing shall be surface mounted

2. Products.

   2.1 Metals, General

   A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless
otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 Aluminum Railing System

A. Rails: ASTM B429 or B221, 6061-T6 aluminum alloy, extruded pipe as noted on the Contract Drawings.


C. Mounting: Cast or extruded aluminum brackets, base flanges for horizontal surfaces, and angled base flanges for stair stringers and ramps.

D. Toe Plates: Aluminum alloy, ¼” x 4” plate with anchors or brackets unless otherwise noted on the Contract Drawings.

E. Chain: 3/16 inch welded 316 stainless steel; provide stainless steel swivel eye snaps and SS threaded eyebolts.

F. Aluminum Surfaces: Mill finish.

G. Apply one coat of bituminous paint to conceal aluminum surfaces in contact with cementitious or other dissimilar materials.

2.3 Aluminum Pipe

A. Post: ASTM B429, unless otherwise noted on Contract Drawings.

B. Ring Top: 1-1/2 inch diameter threaded ring top, aluminum, unless otherwise noted on the Contract Drawings.

C. Support Sleeve: PVC SCH 80 Pipe in top slab. 6-inch long with I.D. sufficient to accept 1-1/2 inch SCH 80 aluminum pipe.

2.4 Fabrication

A. Shop-weld aluminum.

B. Provide cast or extruded mountings for mounting and anchoring.

2.5 Fasteners

A. General: Provide Type 316 stainless steel fasteners.

B. Fasteners for Anchoring Railing to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of constructions indicated and capable of withstanding design loads.

C. Anchors: In accordance with Section 05501.
3. **Execution.**

3.1 Installation

A. Install components plumb and level, straight and true, accurately fitted, free from distortion or defects.

B. Mount and anchor railings in place with cast or extruded mountings. Maintain manufacturer’s recommended edge distances.

C. Install toe plates straight and true with not more than ¼ inch clearance above floor.

END OF SECTION
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing center support column, radial shaped treads and spiral handrail. The arrangement of the stairs shall be in accordance with the Contract Drawings and under all circumstances access to the stair shall be fully clear into the room.

B. Definition: Spiral Stair is a stair with a closed circular form, having uniform sector shaped treads and a supporting center column.

C. Related Sections

- 01600 Materials and Equipment
- 16650 Starting of System
- 05500 Miscellaneous Metal Items
- 05501 Anchor Bolts and Anchors
- 05520 Handrails and Railings

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Submit shop drawings sealed by a Professional Engineer licensed to practice in the Commonwealth of Virginia.

2) Indicate detailed stair configuration, supported loads, supporting accessories and connections, required floor opening and stair height tolerances and other measurements affecting stair.

3) Provide layout showing entrance and exit from stair at top and bottom.

4) Product Data: Submit details of stair components and connection details.

5) Design Data: Submit design calculation prepared by a Professional Engineer licensed to practice in the Commonwealth of Virginia.

6) Manufacturer’s Installation Instructions: Indicate procedures and sequence of installation of components.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

C. ASTM International (ASTM)

1) ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

2) ASTM B632/B632M – Standard Specification for Aluminum-Alloy Rolled Tread Plate

1.4 Design Requirements

A. Design stair assembly to support a minimum live load of 100 lbs/sq ft. Design stair platform and treads to support a minimum concentrated load of 300 lbs applied at the center of the platform and tread span.


C. Minimum Load to Handrail without Permanent Set: 200lb. force in any direction.

D. Number of Treads per 360 Degrees of Stair Rotation: 12 clockwise rotation going up. Layout of entrance and exit to stair shall conform to building layout at both top and bottom of stairs and shall provide adequate clearance.

E. Nominal Stair Diameter: 60 inches. Opening in slab shall be 64-inches.

F. Baluster Attachment: Two treads.

G. Maximum Space between Upright: 6 inches.

H. Minimum Tread Depth: 7-1/2-inches minimum clear tread depth at a point 12-inches from the narrow edge.

I. Minimum Headroom: 78-inches.

J. Maximum Riser Height: 9-1/2-inches.

K. Minimum Stairway Clear Width: 26-inches at or below the handrail.

L. Stair entry and exit points shall be as indicated on the Contract Drawings.

1.5 Qualifications

A. Manufacturer: Company specializing in manufacturing products specified in this section with a minimum of three years documented experience.

2. Products

2.1 General
A. Class: AMP-501; Industrial.

2.2 Components

A. Tread Material: ASTM B632/B632M; 6061-T6; Aluminum, radial tread with nosing.
B. Column: Aluminum, with drilled aluminum plate for base anchorage, drilled for attachment.
C. Handrail: ASTM B221; 6061-T6; Aluminum.
D. Balusters: ASTM B221; 6061-T6; Aluminum.

2.3 Accessories

A. Attachments and Fasteners: Stainless steel adhesive anchors.
B. Vertical Column Cap: Aluminum.
C. Tubular Handrail Ends: Aluminum.

2.4 Fabrication

A. Fabricate stair components to permit site assembly and installation.

2.5 Factory Finishing

A. Vertical Column: Mill finish.
B. Top Surface of Treads: Checkered plate with mill finish.
C. Handrail: Mill finish.
D. Balusters: Mill finish.
E. All mill surfaces shall be ground smooth and have no sharp protrusions or edges.

3. Execution

3.1 Examination

A. Verify field measurements are acceptable to suit stair assembly tolerances.
B. Advise the OWNER when field conditions exceed adjustment limits of attachments.
C. Do not field cut to modify stair components.
D. Verify anchors are correctly positioned.

3.2 Installation
A. Anchor components rigidly and securely to building structure.

3.3 Erection Tolerances

A. Maximum Variation from Plumb: ½ inch for full heights of stair.
B. Maximum Variation from Level: 1/8 inch.

END OF SECTION
Section 06200 – Rough and Finish Carpentry

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing lumber for wooden construction and miscellaneous related items.

B. Related Sections

01600 Materials and Equipment
07311 Asphalt Shingles
07900 Joint Sealants
09900 Painting

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Product Data: For each type of process and factory-fabricated product indicated, include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that materials comply with requirements.

2) Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Include species and ALSC Board of Review for each use and design value.

3) ICC-ES Evaluation Reports for wood preservative treatments, fasteners, engineered wood products, shear panels and anchors.

1.3 Product Handling

A. Delivery and Storage

1) Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

2) For lumber and plywood pressure treated with waterborne chemicals, stack with blocking between each course to provide air circulation.

1.4 Project Conditions

A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.
References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. American Forest & Paper Association
   1) Details for Conventional Wood Frame Construction

C. U.S. Department of Commerce, National Institute of Standards and Technology
   1) DOC PS 1 - U.S. Product Standard for Construction and Industrial Plywood
   2) DOC PS 2 - Performance Standard for Wood-Based Structural-Use Panels
   3) DOC PS 20 – American Softwood Lumber Standard

D. American Wood Protection Association (AWPA)
   1) AWPA U1 - Use Category System: User Specification for Treated Wood
   2) AWPA M4 –Care of Preservative-Treated Wood Products

E. ASTM International (ASTM)
   1) ASTM A 153/A 153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   2) ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
   3) ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts
   4) ASTM A 653/A 653 M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or锌-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   5) ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

F. Northeastern Lumber Manufacturers' Association (NELMA)
   1) Standard Grading Rules for Northeastern Lumber

G. National Lumber Grades Authority (NLGA)
   1) Standard Grading Rules for Canadian Lumber.
H. West Coast Lumber Inspection Bureau (WCLIB)
   1) Standard No. 17: Grading Rules for West Coast Lumber

I. Western Wood Products Association (WWPA)
   1) Western Lumber Grading Rules

J. The Southern Pine Inspection Bureau
   1) Standard Grading Rules for Southern Pine Lumber

K. ICC Evaluation Service, LLC
   1) ICC-ES AC70: Fasteners Power Driven into Concrete, Steel, and Masonry Elements

2. Products.
   2.1 Materials

   A. All materials furnished under this section shall be new. No used or re-used materials shall be allowed for the installation of the work. This Section includes the following:

      1) Wood framing
      2) Wood supports
      3) Wood blocking
      4) Wood cants
      5) Wood nailers
      6) Wood furring
      7) Wood grounds
      8) Wood exterior sheathing
      9) Wood structural panels
     10) Dimensioned lumber
     11) Plywood backing panels
     12) Fasteners and metal framing anchors
     13) Wood Trim
2.2 Wood Products, General

A. Inspection Agencies

1) Inspection agencies and the abbreviations used to reference with lumber grades and species include the following:

   (a) SPIB – Southern Pine Inspection Bureau

   (b) WWPA – Western Wood Products Association

   (c) NELMA - Northeastern Lumber Manufacturers' Association

   (d) NLGA – National Lumber Grades Authority

   (e) WCLIB – West Coast Lumber Inspection Bureau

B. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1) Factory marks each piece of lumber with grade stamp of grading agency.

2) For exposed lumber mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.

3) Provide dressed lumber, S4S, unless otherwise indicated.

4) Provide dry lumber with 15 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

5) A firm having a minimum of 5 years’ experience with this type fabrication shall fabricate wood roof trusses and trussed rafters. Trusses shall be designed to safely carry all dead loads plus 30 pounds per square foot live load.

C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

D. Engineered Roof Trusses: Provide Engineering calculations for all mechanical and strap fasteners demonstrating compliance with the local building code. Calculations to be sealed by a Professional Engineer licensed in the Commonwealth of Virginia. The use of Engineered Roof Trusses must be approved by the OWNER.

E. Allowable Design Stresses: Meet or exceed those indicated by manufacturers’ published values determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
2.3 Wood Preservative Treated Materials

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 (interior no ground contact), Use Category UC3b (exterior no ground contact), Use Category UC4a (interior and exterior in contact with the ground)

B. Kiln-dry material after treatment to a maximum moisture content of 15 percent for lumber and plywood.

C. Mark each treated item with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

D. Application: Treat items indicated on Contract Drawings, and the following:

1) Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2) Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

3) Wood framing members less than 18 inches above grade.

4) Wood floor plates that are installed over concrete slabs directly in contact with earth.

2.4 Dimensioned Lumber

A. General: Of grades indicated according to the American Lumber Standards Committee National Grading Rule provisions of the grading agency indicated.

B. Framing other than Non-Load-Bearing Partitions: Construction or No. 2 grade and any of the following species:

1) Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south; NLGA, WCLIB, or WWPA.

2) Hem-fir or Hem-fir (north); NLGA, WCLIB, or WWPA.

3) Southern pine; SPIB.

4) Spruce-pine-fir (south) or Spruce-pine-fir; NELMA, NLGA, WCLIB, or WWPA.

C. Exposed Framing/Trim: Hand select material for uniformity of appearance and freedom from characteristics that would impair finish appearance.

1) Species and Grade: As indicated above for load-bearing construction of same type or:

   (a) Hem-fir or Hem-fir (north), Select Structural grade; NLGA, WCLIB, or WWPA.
(b) Southern pine, No.1 or better unless otherwise indicated on the Contract Drawings; SPIB.

c) Spruce-pine-fir or Spruce-pine-fir, Select Structural grade; NELMA, NLGA, WCLIB, or WWPA.

2.5 Miscellaneous Lumber

A. Provide Spruce-Pine-Fir or better unless otherwise indicated on the Contract Drawings for support or attachment of other construction, including the following:

1) Rooftop equipment bases and support curbs
2) Blocking
3) Cants
4) Nailers
5) Furring
6) Grounds

2.6 Wood Based Sheathing


B. Plywood Roof Sheathing: DOC PS 1, Exterior, Structural I, ¾" T&G sheathing.

2.7 Plywood Backing Panels

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch thick.

2.8 Miscellaneous Materials

A. Fasteners:

1) Provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M unless noted otherwise.
2) Fastener diameter shall be as noted on the Contract Drawings.
3) Nails: ASTM F1667.
4) Power-Driven Fasteners: Fasteners with an evaluation report based on ICC-ES AC70, acceptable to the OWNER.
5) Bolts: Steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers.

B. Metal Framing Anchors: Made from steel sheet complying with ASTM A653/A653/M.

1) Minimum load ratings as noted on the Contract Drawings by referencing Simpson Strong-Tie components.

2) Interior locations: ASTM A 653/A 653 M G60; Hot-dip, zinc coated steel.

3) When in contact with preservative treated lumber: ASTM A 653/A 653M; structural steel (SS), high strength low-alloy steel Type A, or Type B; G185 coating.

4) Exterior Locations: Stainless Steel Sheet ASTM A 666, Type 316.

C. Research/Evaluation Reports: Provide products acceptable to authorities having jurisdiction and for which model code research/evaluation reports exist that show compliance of metal framing anchors, for application indicated, with building code in effect for Project.

D. Allowable Design Loads: Meet or exceed those indicated by manufacturers’ published values determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

E. Hurricane anchors shall be:

1) Hot dip galvanized after fabrication.

2) Suitable for a Category II Hurricane and be designed to resist a minimum of 1000 lb uplift and a 1000 lb horizontal shear loading.

3) Located at a maximum spacing of 16 inches.

3. Execution.

3.1 General

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

C. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
D. Use screw fasteners for all work, unless otherwise indicated. Countersink heads and where exposed to view fill with approved filler material and sand finish.

1) Framing Standard: Comply with AFPA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.

2) Framing with engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

3) Fastening Methods:
   (a) Soffits and ceilings: Glue and nail to wood framing.
   (b) Sheathing: Glue and nail to wood framing.
   (c) Plywood Backing Panels: Nail to supports.

END OF SECTION
Section 07311 – Asphalt Shingles

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing asphalt shingles, underlayment, nails, ridge vents when required, rain diverters when required and prefabricated vent products for steep roofs, provided complete and ready for operation.

B. Related Sections

01600 Materials and Equipment
06200 Rough and Finish Carpentry
07620 Sheet Metal Flashing and Trim
07900 Joint Sealants

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Product data for each type of product specified, including details of construction relative to materials, dimensions of individual components, profiles, textures, and colors.

2) Manufacturer’s standard and special warranty.

1.3. References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. Asphalt Roofing Manufacturers Association:

1) Residential Asphalt Roofing Manual

C. ASTM International (ASTM)

1) ASTM D3462/D3462 M – Standard Specification for Asphalt Shingles Made From Glass Felt and Surfaced with Mineral Granules


5) ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

D. National Roofing Contractors Association (NRCA)
   1) NRCA – Steep-slope Roof System Manual

E. National Roofing Contractors Association

F. Underwriters Laboratories (UL)
   1) UL 790 – Standard Test Methods for Fire Tests of Roof Coverings
   2) UL 997 – Wind Resistance of Prepared Roof Covering Materials

1.4 Quality Assurance
   A. Wind-Resistance-Test Characteristics: Provide products identical to those tested according to ASTM D 3161 or UL 997 and passed. Identify each bundle of asphalt shingles with appropriate markings of applicable testing and inspecting agency.

1.5 Delivery, Storage, and Handling
   A. Deliver materials to Project site in manufacturer's unopened bundles or containers with labels intact.
   
   B. Handle and store materials at Project site to prevent water damage, staining, or other physical damage. Store roll goods on end. Comply with manufacturer's recommendations for job-site storage, handling, and protection.
   
   C. Protect roofing materials from weather, sunlight and moisture when not installed on same day as delivery to the project or when work is not in progress.

1.6 Project Conditions
   A. Weather Limitations: Proceed with installing asphalt shingles only when existing and forecasted weather conditions will permit work to be performed according to manufacturers' recommendations and warranty requirements, and when substrate is completely dry.

2. Products

2.1 Asphalt Shingles
   A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.
B. Color shall be Charcoal Gray Blend.

C. Shingles to be manufacturer’s 40-year designation, with first 10 years non-prorated.

D. Workmanship Warranty: 25 years.

E. Wind Speed Warranty: Asphalt shingles will resist blow-off or damage caused by wind speeds up to 110 mph for 15 years.

2.2 Metal Trim and Flashing

A. Sheet Metal Materials: Furnish sheet metal materials as specified in Section 07620.

2.3 Accessories

A. Underlayment for shingles shall be waterproofing underlayment, total minimum thickness of 60 mil, fiberglass reinforced with SBS modified asphalt (15lb.), complying with ASTM D1970/D1970 M and UL approved (two layers).

B. Asphalt Plastic Cement: Non-asbestos fibrated asphalt cement, complying with ASTM D 4586, Type II, asbestos free.

C. Nails: ASTM F1667, unless otherwise recommended by the shingle manufacturer nails shall be hot-dip galvanized steel, 0.120-inch diameter barbed shank, sharp-pointed, conventional roofing nails with a minimum 3/8-inch diameter head and of sufficient length to penetrate 3/4 inch into solid decking or at least 1/8 inch through plywood sheathing.

D. Where nails are in contact with flashing, prevent galvanic action by providing nails made from the same metal as the flashing.

E. Rain diverters: Vinyl, where required on the Contract Drawings.

F. Ridge Vent: Nailable, designed for shingle overlay. Color as approved by the OWNER.

3. Execution

3.1 Examination

A. Examine substrate for compliance with requirements for substrates, installation tolerances, and other conditions affecting performance of asphalt shingles. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 Preparation

A. Clean substrates of projections and substances detrimental to application. Cover knotholes or other minor voids in substrate with sheet metal flashing secured with noncorrosive roofing nails.
B. Coordinate installation with flashings and other adjoining work to ensure proper sequencing. Do not install roofing materials until all vent stacks and other penetrations through roof sheathing have been installed and are securely fastened against movement.

3.3 Installation


B. Fasten asphalt shingles to roof sheathing with nails.

C. Felt Underlayment: Apply layer of felt underlayment horizontally over the entire surface to receive asphalt shingles, lapping succeeding courses a minimum of 2 inches, lap ends a minimum of 4 inches, and hips and valleys a minimum of 6 inches. Fasten felt with a sufficient number of roofing nails or noncorrosive staples to hold underlayment in place until asphalt shingle installation. Apply the second layer of felt underlayment on roof deck over lapping joints on first layer by a minimum of 12 inches.

D. Flashing: Install metal flashing and trim as indicated and according to details and recommendations of the “Asphalt Roofing” section of “The NRCA Steep Roofing Manual” and ARMA’s “Residential Asphalt Roofing Manual.”

E. Install asphalt shingles, beginning at the roof’s lower edge, with a starter strip of roll roofing or inverted asphalt shingles with tabs removed. Fasten asphalt shingles in the desired weather exposure pattern; use the number of fasteners per shingle recommended by the manufacturer. Use vertical and horizontal chalk lines to ensure straight coursing.

1) Cut and fit asphalt shingles at ridges, and edges to provide maximum weather protection. Provide same weather exposure at ridges as specified for roof. Lap asphalt shingles at ridges to shed water.

F. Use fasteners at ridges of sufficient length to penetrate sheathing as specified.

G. Install pre-molded vent products in full accordance with manufacturers’ instructions.

H. Valleys: Provide either closed cut or woven valleys.

1) Closed Cut Valleys: Provide 36 inch wide valley lining of single layer of smooth-surfaced or mineral-surfaced roll roofing, with mineral-surface facing down, for full length of valleys as follows.

(a) Center lining in valley over underlayment. Provide minimum 12 inch end laps in the lining and seal laps with asphalt roof cement. Fasten lining to hold it in place until shingles are applied.

(b) Apply first regular course of shingles along eaves of one of the intersecting roof planes and across valley. Extend course at least 12 inches onto adjoining
roof.

(c) Apply succeeding course in same manner as first course, extending across valley and onto adjoining roof.

(d) Press shingles tightly into valley and nail in normal manner, except apply nails not closer than 6 inches to valley centerline, and apply additional nail in top corner of each shingle crossing valley.

(e) Apply shingles on the adjoining roof plane, starting alone eaves and across valley onto previously applied shingles. Trim overlapping courses back to a line parallel to and a minimum of 2 inches back from valley centerline.

(f) Trim one inch on a 45 degree angle from upper corner of each end shingle. Embed end shingles in a 3 inch wide band of asphalt roof cement.

2) Woven Valleys: Provide valley lining as specified for closed cut valley. Lay valley shingles over lining by either of the following methods:

(a) Method I: Apply regular shingles on both roofs simultaneously. Weave each course in turn over the valley. Lay the first regular course of shingles along eaves of roof up to and over valley. Extend course along adjoining roof deck at least 12 inches. Carry first regular course of shingles of adjoining roof over valley on top of previously applied shingles. Lay succeeding courses alternately, weaving valley shingles over each other for full length of valley.

(b) Method II: Apply regular shingles on each roof surface separately to a line about 3 feet from center of valley, and weave valley shingles in place later, as specified for Method I. In following either method, press shingles tightly into valley, and fasten in normal manner; except apply nails not closer than 6 inches to valley centerline, and apply additional nail in top corner of terminal shingle on both sides of valley.

I. Install in accordance with the manufacturer’s printed instructions.

3.4 Adjusting

A. Replace any damaged materials installed under this Section with new materials that meet specified requirements.
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing through-wall flashing, counter flashing and other miscellaneous metal flashing and trim.

B. **Related Sections**

   01600 Materials and Equipment
   03300 Cast-in-Place Concrete
   04200 Cavity Wall Masonry System
   07311 Asphalt Shingles
   07900 Joint Sealants

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

   1) Product Data including manufacturer’s materials and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.

   2) Shop Drawings of each item specified showing layout, profiles, methods of joining, and anchorage details.

   3) Samples of sheet metal flashing, trim, and accessory items, in the specified finish. Where finish involves normal color and texture variations, including sample sets composed of 2 or more units showing the full range of variations expected.

      (a) 12-inch long Samples of each fabricated section shown and exposed as finished work. Provide complete with specified finish.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. **American Welding Society (AWS)**

   1) AWS D1.2/D1.2M – Structural Welding Code – Aluminum

C. **ASTM International (ASTM)**

   1) ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy
Extruded Bars, Rods, Wire, Profiles, and Tubes

2) ASTM B32 – Standard Specification for Solder Metal

3) ASTM B370 – Standard Specification for Copper Sheet and Strip for Building Construction

4) ASTM C920 - Standard Specification for Elastomeric Joint Sealants


D. Factory Mutual

1) Loss Prevention Data Sheet 1-49

E. The Society for Protective Coatings (SSPC)

1) SSPC – Paint 33 Coal Tar Mastic, Cold-Applied

F. Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA)


G. United States Federal Specifications

1) UU-B-790 – Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

1.4 Performance Requirements

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

B. Fabricate and install flashings at roof edges to comply with recommendations of FM Loss Prevention Data Sheet 1-49 for the following wind zone:

1) Wind Zone 2: Wind pressures of 31 to 45 psf.

1.5 Quality Assurance

A. Installer Qualifications: Engage an experienced installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.6 Project Conditions

A. Coordinate Work of this Section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance, durability of work, and protection of materials and finishes.
2. **Products.**

2.1 **Metals**

A. Stainless Steel Sheet: ASTM A240/A240 M or ASTM A666, Type 316, soft annealed, with No. 2D finish, except where harder temper is required for forming or performance, minimum 0.019 inch thick, unless otherwise indicated.

B. Aluminum: ASTM B209, manufacturer standard alloy, temper to suit forming and performance, smooth surface, mill finish.

2.2 **Reglets**

A. General: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counter flashing pieces and compatible with flashing indicated.

B. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.

C. Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counter-flashing or where Contract Drawings show reglet without metal counter-flashing.

D. Counter-flashing Wind-Restraint Clips: Provide clips to be installed before counter-flashing to prevent wind uplift of the counter-flashing lower edge.

   1) Material: Stainless steel, 0.019 inch thick.

2.3 **Miscellaneous Materials and Accessories**

A. Solder for Stainless Steel: ASTM B 32, Grade Sn60, used with an acid flux of type recommended by stainless-steel sheet manufacturer; use a noncorrosive rosin flux over tinned surfaces.

B. Stainless-Steel Welding Rods: Type recommended by stainless-steel sheet manufacturer for type of metal sheets furnished.

C. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.

D. Asphalt Mastic: SSPC-Paint 33, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil (0.4-mm) dry film thickness per coat.

E. Elastomeric Sealant: ASTM C920, Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Section 07900.
F. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.

G. Paper Slip Sheet: 3-lb/square red rosin, sized building paper conforming to FS UU-B-790, Type I, Style 1b.

H. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.

I. Roofing Cement: ASTM D 4586, asbestos free, asphalt based.

2.4 Fabrication, General

A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.

B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Form exposed sheet metal work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.

D. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.

E. Expansion Provisions: Space movement joints at maximum of 10 feet on centers with no joints allowed within 24 inches of a corner or intersection. Where lapped or bayonet-type expansion provisions in work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

F. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

G. Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation material recommended by manufacturer.

H. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.

I. Fabricate cleats and attachment devices from the same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
1) Size: As recommended by SMACNA manual or sheet metal manufacturer for application, but never less than the thickness of the metal being secured.

2.5 Sheet Metal Fabrications

A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements; but not less than that listed below for each application and metal.

B. Through wall flashing: Fabricate from the following material:
   1) Stainless Steel: 0.016 inch thick or as noted on the Contract Drawings.

C. Metal Flashing: Fabricate from the following material:
   1) Stainless Steel: 0.019 inch thick.

D. Counter-flashing: Fabricate from the following material:
   1) Stainless Steel: 0.019 inch thick.

E. Flashing Receivers: Fabricate from the following material:
   1) Stainless Steel: 0.016 inch thick.

F. Drip Edges: Fabricate from the following material:
   1) Aluminum: 0.032 inch thick.

G. Eave Flashing: Fabricate from the following material:
   1) Aluminum: 0.032 inch thick.

H. Roof-Penetration Flashing: Fabricate from the following material:
   1) Stainless Steel: 0.019 inch thick.

3. Execution

3.1 Examination

A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 Installation

A. General: Unless otherwise indicated, install sheet metal flashing and trim in compliance with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units;
conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Install exposed sheet metal work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Roof-Edge Flashings: Secure metal flashings at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.

D. Chimney Flashings: Uniformly coat masonry surfaces which are to receive flashing with asphalt primer applied at rate of one gallon per 100 square feet. Apply shingles over underlayment up to front face of chimney. Apply metal front base flashing with lower section extending at least 4 inches over shingles. Set base flashing in a 1/16 inch coating of asphalt roof cement on shingles and chimney face. Apply metal step flashing at sides in a coating of asphalt roof cement. Embed end shingles in each course that overlaps step flashing with asphalt roof cement. Apply metal rear base flashing over cricket and back of chimney in coating of asphalt roof cement. Apply end shingles in each course up to cricket, and cement in place. Lap base flashing minimum of 3 inches with metal counter flashing.

E. Eave Flashing: One piece in width, applied in 8 to 10 foot lengths with expansion joints spaced as specified on the Contract Drawings. Provide a 3/4 inch continuous fold in the upper edge of the sheet to engage cleats spaced not more than 10 inches on center. Locate the upper edge of flashing not less than 18 inch from the outside face of the building, measured along the roof slope. Fold lower edge of the flashing over and loose-lock into a continuous edge strip on the fascia. Where eave flashing intersects metal valley flashing, secure with one inch flat locked joints with cleats that are 10 inch on center.

F. Expansion Provisions: Provide for thermal expansion of exposed sheet metal work. Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except where pre-tinned surface would show in finished work.

H. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.

1) Use joint adhesive for nonmoving joints specified not to be soldered.

2) Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin
edges to be seamed, form seams, and solder.

I. Separations: Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.

1) Underlayment: Where installing stainless steel or aluminum directly on cementitious or wood substrates, install a slip sheet of red-rosin paper and a course of polyethylene underlayment.

2) Bed flanges of work in a thick coat of roofing cement where required for waterproof performance.

J. Counter-flashings: Coordinate installation of counter-flashings with installation of assemblies to be protected by counter-flashing. Install counter-flashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counter-flashing joints a minimum of 2 inches and bed with sealant.

K. Roof-Penetration Flashing: Coordinate roof-penetration flashing installation with roofing and installation of items penetrating roof. Install flashing as follows:

1) Turn flashing down inside vent piping, do not to block vent piping with flashing.

2) Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.

3.3 Cleaning and Protection

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim work during construction is without damage or deterioration other than natural weathering at the time of acceptance by the OWNER.

END OF SECTION
Section 07900 – Joint Sealants

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing flexible, adhesive sealants, bedding and related materials.

B. Related Sections

01600 Materials and Equipment
03300 Cast in Place Concrete
04200 Cavity Wall Masonry System
06200 Rough and Finish Carpentry
07311 Asphalt Shingles
07620 Sheet Metal Flashing and Trim
08100 Steel Doors and Frames
09900 Painting
15062 Interior Pipe, Fittings, Valves, and Specialties

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Submit product data indicating sealant chemical characteristics, performance criteria, limitations, color availability and intended use.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. ASTM International (ASTM)


2) ASTM C834 – Standard Specification for Latex Sealants


6) ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants
7) ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints

1.4 Quality Assurance

A. Applicator: Company specializing in applying the work of this Section with minimum five years’ documented experience, trained and approved by the manufacturer.

1.5 Environmental Requirements

A. Do not install solvent curing sealants in enclosed building spaces.

B. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

C. Do not install joint sealants in temperatures below 40 degrees Fahrenheit.

D. Do not install joint sealants where substrates are wet.

E. Do not install joint sealants in joints less than the widths allowed by the manufacturer.

F. Do not install joint sealants in joints containing contaminants interfering with adhesion until the contaminants have been removed.

1.6 Sequencing and Scheduling

A. Coordinate the work of this Section with all work with exposed and hidden surfaces requiring sealants.

1.7 Preconstruction Field Testing


1) Retest sealants that fail for adherence until satisfactory adhesion is obtained.

2) Sealants not failing by adhesive and absent of other noncompliance will be considered satisfactory.

3) Do not use sealants that fail adhesion to joint substrates.

2. Products

2.1 Sealants

A. Exterior joints in vertical surfaces and non-traffic horizontal joints including roof flashing; masonry control and expansion joints; overhead control and expansion
joints; perimeter of exterior doors, windows and louvers; (except as specified otherwise): Silicone, Non-staining, S, NS, 100/50, NT: Non-staining, single-component, non-sag, plus 100 percent and minus 50 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

B. Interior joints in vertical surfaces and horizontal non-traffic surfaces including interior control joints surfaces of exterior walls; and perimeter joints at doors, windows and louvers: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

C. Aluminum threshold and sill plate setting bed: Butyl-Rubber-Based Joint Sealants, ASTM C 1311.

D. Interior joints in horizontal traffic surfaces, including isolation joints in cast-in-place concrete floors: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and non-traffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.

E. Color: Match adjacent surfaces where not painted, or as otherwise selected by the OWNER from manufacturer’s standard colors.

2.2 Accessories

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application, to prevent sealants from adhering to inflexible joint materials or materials at the back of the joint.

2.3 Joint Backing

A. ASTM C1330, Type C closed cell cylindrical backing rod, size and density to control sealant.

B. Materials shall be free of oil or other staining elements. Oakum and other types of absorptive materials shall not be used.

3. Execution

3.1 Examination

A. Verify that surfaces, and joint openings are ready to receive work and field measurements are as shown on Contract Drawings and recommended by the manufacturer.

B. Beginning of installation means installer accepts existing surfaces & substrate.
3.2 Preparation

A. Clean and prime joints in accordance with manufacturer's instructions. Clean porous joints by brushing, mechanical grinding, abrading or combination of these methods. Clean nonporous joints with chemical cleaners that do not harm, stain, or interfere with sealant adhesion.

B. Remove loose materials and foreign matter which might impair adhesion of sealant.

C. Prime joints recommended by the manufacturer or indicated by preconstruction testing. Mask primed joints with masking tape to prevent or damage adjacent materials. Remove masking tape immediately after tooling joints.

D. Verify that joint backing and release tapes are compatible with sealant.

E. Protect elements surrounding the work of this Section from damage or disfiguration.

3.3 Installation

A. Install sealant in accordance with manufacturer's instructions and ASTM C1193

B. Measure joint dimensions and size materials to achieve required width/depth ratios.

C. Install bond breaker where joint backing is not used.

D. Tool non-sag sealants immediately after application and prior to skinning. Provide concave profile per Figure 8A in ASTM C1193.

E. Protect joints during and after curing to prevent contact with contaminating substances.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

H. Tool joints as detailed or as appropriate.

3.4 Cleaning and Repairing

A. Clean adjacent soiled surfaces.

B. Repair or replace defaced or disfigured finishes caused by work of this Section.

3.5 Protection of Finished Work

A. Protect finished installation in accordance with the manufacturer’s recommendations.
B. Protect sealants until cured.

END OF SECTION
1. General

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing steel doors, frames and hardware.

B. Related Sections

01600 Materials and Equipment
01650 Starting of System
04200 Cavity Wall Masonry System
07900 Joint Sealants
09900 Painting

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. ASTM International (ASTM)

1) ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

2) ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

3) ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

4) ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process


6) ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

C. Builders Hardware Manufacturers Association (BHMA)

1) BHMA A156.1 - Butts and Hinges

2) BHMA A156.4 - Door Controls-Closers

3) BHMA A156.6 - Architectural Door Trim

4) BHMA A156.16 – Auxiliary Hardware

5) BHMA A156.21 – Thresholds

6) BHMA A156.22 - Door Gasketing and Edge Seal Systems Frames

D. Steel Door Institute (SDI)

1) SDI 100 - Specifications for Standard Steel Doors and Frames

2) SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors

3) SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames

4) SDI A250.8 - Specifications for Standard Steel Doors and Frames

5) SDI A250.11 Recommended Erection Instructions for Steel Frames

1.4 Product Handling

A. All materials shall be delivered to the site in sealed, undamaged containers fully identified with the manufacturer's name, project and door location, door type, door rated, color, and weight. Store materials in original cartons; heads up, with minimum 1/4 inch space between each, in such a way to prevent falling or damage to door.

B. Do not use unvented plastic to store doors or frames.

C. Inventory and tag hardware when delivered to the site.

1) Deliver keys to the OWNER.

2. Products

2.1 Performance Requirements

A. Windborne-Debris Impact Resistance: Pass missile-impact and cyclic-pressure tests according to ASTM E 1886 and test information in ASTM E 1996 for Wind Zone 1 –
2.2 Doors and Frames: Maximum-Duty Doors and Frames: SDI A250.8, Level 4; SDI 250.4, Level A

A. Doors:

1) Face: ASTM A653/A653M, Commercial Steel (CS), Type B; Metallic-coated steel; 0.067-inch thickness (16 gage); minimum A60 coating.

2) Thickness: 1-3/4”.

3) Edge: Model 1, Full Flush or Model 2 Seamless.

4) Core (Exterior): Polyisocyanurate.

5) Face Panel: At exterior doors provide 6 panel raised sections face panels resembling wood grain finished doors; at interior locations provide flush.

B. Frames: ASTM A653/A653M, Commercial Steel (CS), Type B; Metallic-coated steel; 0.067-inch thickness (16 gage); minimum A60 coating; Knocked down.

1) Fabricate in one piece.

2) Exposed Fasteners: Countersunk, flat-head for exposed fasteners.

3) Silencers: Non-weatherstripped frames only; provide 3 drilled stops at single doors frames in each jamb; provide 2 drilled stops in head jamb for double door frames.

C. Finish: Color to be Courthouse Beige. Paint in accordance with Section 09900.

2.3 Frame Anchors: ASTM A1008/A1008M or ASTM A1011/A1011M; hot dip galvanized ASTM A153/A153M, Class B.

A. Type: In accordance with maximum-duty frames.

B. Quantity: Minimum of 3 at each jamb, except provide 1 additional at each jamb for frames over 7-feet.

2.4 Fabrication

A. Prepare door in factory for hardware from templates, and according to SDI A250.6.

2.5 Hardware

A. The CONTRACTOR shall coordinate installation of all hardware with door manufacturer. All hardware shall be installed in accordance with manufacturer's recommendations.

B. Hardware shall be finished US 32D satin stainless steel. Hardware numbers are
provided to indicate the type to be used. The approval of the OWNER is required on all hardware and equivalent patterns of other manufacturers may be used with approval. Three (3) butts shall be used on doors under 7-feet; provide 1 additional butt for frames over 7-feet.

C. Door Hardware: Provide the following

1) Locksets - Exterior door lockset shall be deadlocking by knob either side, except when turn button locks outside knob, key outside retracts latch-bolt, outside knob unlocked by turn button and inside knob always free. Shall be master keyed as directed by the OWNER. Interior door locksets shall be passage type.

2) Hinges – BHMA A156.1, template produced; full mortise, 5 knuckle, ball bearing; 0.146 gauge stainless steel.

3) Flush Bolts – BHMA A156.16, minimum 3/4 inch throw; on double door provide stainless steel flush bolts to secure inactive leaf.

4) Door Closer with Holder – BHMA A156.4; Surface mount door closer, adjustable sizes 1-5, parallel arm, regular arm & top jamb applications, (4) hex nuts for 1-3/4' door, aluminum.

5) Door Stop – BHMA A156.16; Assembly fabricated from 316 Stainless with neoprene stop and catch latch - Mounted on outside edge of building slab. Mounted to slab with S.S. adhesive anchors.

6) Door Plate – BHMA A156.6; 8" Kick plate - 4" Mop plate - 0.050-inch thick 316 stainless.

7) Threshold – BHMA A156.22; Aluminum with vinyl insert. Mounted to slab with S.S. adhesive anchors.

8) Gasketing (weatherstripping/sweep) – ASTM A156.21, aluminum receiver with resilient or flexible strip easily replaceable strips. Mount weather stripping on frame at head and jambs. Mount sweep on door at sill.

3. Execution

3.1 Installation

A. Door shall open to the exterior of the building.

B. Install door and frame rigid, properly aligned, securely fastened and plumb. Install steel door and frame in accordance with manufacturer's published instructions.

C. Frames: Install, fit and adjust to comply with SDI A250.11. Pack exterior frames inside with mineral-fiber insulation.

D. Frames: Install, fit and adjust to comply with SDI A250.11.

END OF SECTION
Section 08310 – Hatches

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing hatches on both the interior and exterior of a pump station.

B. Related Sections

01600 Materials and Equipment
01650 Starting of System
03300 Cast-in-Place Concrete
03400 Precast Concrete Valve Vaults

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. ASTM International (ASTM)

1) ASTM A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperatures or High Pressure Service and Other Special Purpose Applications

2) ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes


4) ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate


6) ASTM B632 – Standard Specification for Aluminum-Alloy Rolled Tread Plate

7) ASTM D1187 – Asphalt-Base Emulsions for Use as Protective Coatings for Metal

C. Occupational Safety and Health Administration (OSHA)
D. Code of Federal Regulations (CFR)
   
   1) 29 CFR 1910.145 – Specifications for Accident Prevention Signs and Tags

2. Products

2.1 Hatches

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

B. Load Rating: 300 pounds per square foot.

C. Frame:
   
   1) Material: Extruded aluminum with mitered and welded corners.

   2) Anchors: Continuous type or bolt-on strap type.

   3) Provide frame with built-in neoprene gasket.

   4) Provide angle frames for drywell hatches when shown on the Contract Drawings. Provide channel frames for wet well hatches.

   5) Channel frames shall include an integral 1 ½ inch diameter drainage coupling.

   6) Frames for wet well hatches shall include fall protection grating. Grating shall be aluminum with a high visibility powder coat finish. Hardware shall be Type 316 stainless steel. The grating shall be hinged with an automatic hold-open device. Fall protection grating shall be supplied by the hatch manufacturer.

   7) Apply a bituminous coating to surfaces of frame that will be in contact with concrete.

D. Cover:

   1) Material: 1/4 inch mill finish one piece aluminum diamond plate, reinforced with stiffening ribs (in accordance with ASTM B632).

   2) Hinges: Stainless steel; heavy forged Type 316 with ¼ inch Type 316 stainless steel hinge pins.

   3) Hold - Open Arm: Stainless steel; automatically locks door at 90 degree position; provide aluminum latch to release door for closing.

   4) Locking Post: For wet well hatches, provide a cast aluminum pad lock locking post. Do not provide a locking post for drywell hatches.

   5) Maximum allowable deflection less than length of span/150.
E. Hardware and Fasteners: Type 316 stainless steel.

F. Finish: Factory mill finish for aluminum doors and frames

G. Signs: the CONTRACTOR shall install a sign on each wet well hatch cover which reads “Danger Confined Space Enter by Permit Only”. Sign shall be OSHA compliant and in accordance with the requirements of 29 CFR 1910.145. Sign shall be constructed of 0.055” thick (min.) polyethylene and shall have a matte surface finish. Minimum sign dimensions shall be 10” x 14”. Sign shall be attached to the hatch cover with four ¼” diameter stainless steel Type 316 rivets.

3. Execution.

3.1 Installation

A. Install hatches in accordance with manufacturer’s published instructions.

END OF SECTION
Section 09900 – Painting

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing painting as specified or shown in accordance with best accepted practice.

B. **Related Sections**

01600 Materials and Equipment
03300 Cast-in-Place Concrete
04200 Cavity Wall Masonry System
06200 Rough and Finish Carpentry
07900 Joint Sealants
08100 Steel Doors, Frames and Hardware
14630 Trolley and Runway Beam
15062 Interior Pipe, Fittings, and Valves
15100 Vertical Extended Shaft Centrifugal Pumping Equipment
15150 Non-Clog Submersible Centrifugal Pumps and Drives
15492 Fuel Gas Piping
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16130 Raceways, Boxes, and Fittings

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment

1) **Data: Paint.** The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials.

2) **Instructions: Application.** Manufacturer's current printed product description, and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times between coats for epoxy, moisture-curing polyurethane, and liquid glaze coatings.

3) **Certificates: Lead. Mildewcide and Insecticide.** Volatile Organic Compound (VOC) Content. Certificate stating that paints for interior use contain non-mercurial mildewcide or insecticide. Certificate stating that paints proposed for use contain not more than 0.06 percent lead by weight of the total nonvolatile. Certificate stating that paints proposed for use meet Federal VOC regulations.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The
referenced publications shall be the current effective edition.

B. American Conference of Governmental Industrial Hygienist (ACGIH)
   1) Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices

C. ASTM International (ASTM)
   1) ASTM D 4258 Standard Practice for Surface Cleaning Concrete for Coating

D. Master Painters Institute (MPI)
   1) Referenced painting systems and materials.

E. Steel Structures Painting Council (SSPC)
   1) SSPC SP1 – Solvent Cleaning
   2) SSPC SP 7/NACE WAB-4 - Brush-Off Blast Cleaning
   3) SSPC SP 10/NACE No. 2 - Near-White Blast Cleaning

1.4 Packaging, Labeling, and Storing

A. Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints thinner shall be stored in accordance with the manufacturer's written directions and as a minimum stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 40 and 95 degrees F. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1.5 Approval of Materials

A. When samples are tested, approval of materials will be based on tests of the samples; otherwise, materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the OWNER for testing should the materials appear defective during or after application. In addition to any other remedies under the contract the cost of retesting defective materials will be at the CONTRACTOR'S expense.

1.6 Environmental Conditions

A. Unless otherwise recommended by the paint manufacturer the ambient temperature shall be between 50 and 95 degrees F. Do not apply coatings when the relative humidity exceeds 85 percent; at temperatures less than 5 degrees above the dew point; or to wet or damp surfaces. Do not apply exterior coatings in snow, rain, fog or mist.
1.7 Safety and Health

A. Work shall comply with applicable Federal, State, and local laws and regulations.

B. Worker Exposures: Exposure of workers to hazardous chemical substances shall not exceed limits established by ACGIH, or as required by a more stringent applicable regulation.

C. Toxic Compounds: Toxic products having ineffective physiological warning properties, such as no or low odor or irritation levels, shall not be used unless approved by the OWNER.

D. Training: Workers having access to an affected work area shall be informed of the contents of the applicable material safety data sheets (MSDS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is on which may receive mists and odors from the painting operations. Workers involved in preparation, painting and clean up shall be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

E. Coordination: Work shall be coordinated to minimize exposure of building occupants, other CONTRACTOR personnel, and visitors to mists and odors from preparation, painting and clean-up operations.

2. Products.

2.1 Paint

A. Only materials listed in the latest edition of the MPI Approved Product List (APL) are acceptable.

B. The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the following requirements:

1) Colors and Tints: Colors shall be as selected from manufacturer's standard colors, and indicated. Manufacturer's standard color is for identification of color only. Tinting of epoxy and urethane paints shall be done by the manufacturer.

2) Lead: Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

3) Chromium: Paints containing zinc chromate or strontium chromate pigments shall not be used.

4) Volatile Organic Compound (VOC) Content: Paints shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards.
5) Mildewcide and Insecticide: Mercurial mildewcide shall not be used in interior paint. Insecticide shall not be used in paint.

2.2 Materials

A. MPI #11: Latex, Exterior Semi-Gloss (MPI Gloss Level 5); A pigmented, water based, emulsion type, semi-gloss paint

B. MPI #69: Primer, Bonding, Solvent Based; A solvent based, pigmented primer, used on various types of problematic surfaces to promote adhesion of subsequent coatings.

C. MPI #72: Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7); A solvent based, two component polyurethane, pigmented coating with a gloss finish for interior or exterior brick, block, concrete, plaster, wood and metal surfaces, where abrasion, weathering, chemical and solvent resistance is required.

D. MPI #77: Epoxy, Gloss; A solvent based, gloss, two component, epoxy coating for wall and floor surfaces in moderate to heavy traffic commercial and moderate industrial environments. Resistant to incidental splash and spillage of dilute (5%) sulfuric acid, (15%) hydrochloric acid, (20%) sodium hydroxide, gasoline and heavy duty cleaners and detergents. Used as a self-priming material on smooth, low porosity concrete, masonry and wood surfaces.

E. MPI #80: Primer, Vinyl Wash; A two component, vinyl butyral/phosphoric acid wash primer used over cleaned metal surfaces and zinc rich primers, as a tie coat for subsequent priming with anti-corrosive primers or finish coatings.

F. MPI #82: Epoxy Deck Coating (Slip-Resistant); A solvent based, two component epoxy, non-slip coating for interior and exterior decks. Resistant to abrasion, solvents, fuel and oils. Application by trowel, roller and spray, and may be touched up by brush.

G. MPI #101: Primer, Epoxy, Anti-Corrosive, for Metal; A solvent based, two component, epoxy, anti-corrosive primer for exterior and interior, ferrous and galvanized metal surfaces. Specified for use over new, cleaned metals and as a spot primer or full coat over previous epoxy coatings that have been properly prepared with hand, power tool or abrasive blasting cleaning methods.

H. MPI #108: Epoxy, High Build, Low Gloss; A two component epoxy, high solids, low gloss coating for use on interior or exterior concrete, masonry and primed metal surfaces.

I. MPI #116: Block Filler, Epoxy; A solvent based, two component, epoxy, high solids coating for unfilled, interior and exterior block surfaces that are to be coated with a chemically resistant finish. Resistant to water, alkalis, chemicals and solvents.

3. Execution

3.1 Protection

A. Items not to be painted, which are in contact with or adjacent to painted surfaces, shall be removed or protected prior to surface preparation and painting operations. Items
removed prior to painting shall be replaced when painting has been completed. Following completion of painting, workmen skilled in trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be repaired or replaced to original condition as directed by the OWNER.

B. Protect machinery, electrical panels and motors, couplings and other equipment that may be damaged by paint operations. Clean off paint spots and splashes on areas not designated to receive paint as work proceeds.

C. Ensure hardware and accessories, plates, fixtures, finished work, and similar items are removed or protected.

D. Provide "wet paint" signs.

E. Remove temporary protective wrappings, provided by others for protection of their work, after completion of painting operations.

3.2 Preparation / Application

A. The surfaces to be painted shall be thoroughly cleaned, smooth, free of foreign material and dry before application of any paint. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads, on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas. Sufficient time shall elapse between coats to allow the paint to become completely dry and hard. Elapsed time between coats shall not be less than 24 hours, and shall be longer if required. No painting shall be done in rainy or excessively damp weather, or when the temperature is below 45 degrees F. The paint shall be applied by experienced painters, in full body, without runs, sags, or excessive brush marks. Thinning will be permitted only as allowed by the manufacturer's directions.

B. Concrete and Masonry Surfaces: Concrete and masonry surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Surfaces shall be cleaned in accordance with ASTM D 4258. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer's recommended conditioner prior to application of the first coat.

C. Ferrous Surfaces

1) New Items: Ferrous surfaces, including those that have been shop-coated, shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC SP2, power tools according to SSPC SP3 or by sandblasting according to SSPC SP 7/NACE WAB-4. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.
2) Existing to Remain Items: All existing ferrous surfaces shown to remain shall be cleaned according to SSPC SP 10/NACE No.2, Near-White Blast Cleaning. All existing paint, rust and other debris/coatings shall be removed before painting/coating. The surfaces shall be protected at all times from further corrosion.

D. Nonferrous Metallic Surfaces: Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1.

E. Mastic-Type Surfaces: Mastic-type surfaces shall be prepared by removing foreign material.

F. Wood Surfaces: Wood surfaces shall be cleaned of foreign matter. Moisture content of the wood shall not exceed 15 percent as measured by a moisture meter, unless otherwise authorized. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints. Small, dry seasoned knots shall be scraped, cleaned, and given a thin coat of commercial knot sealer, before application of the priming coat. Pitch on large, open, unseasoned knots and all other beads or streaks of pitch shall be scraped off, or, if it is still soft, removed with mineral spirits or turpentine, and the resinous area shall be thinly coated with knot sealer. Finishing nails shall be set, and all holes and surface imperfections shall be primed. After priming, holes and imperfections in finish surfaces shall be filled with putty or plastic wood filler, colored to match the finish coat. If natural finish is required, allowed to dry, and sanded smooth. Putty or wood filler shall be compatible with subsequent coatings.

3.3 Mixing and Thinning

A. When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the CONTRACTOR from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.4 Application

A. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film will be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designated for the coating to be applied and the surface to be coated. Special attention shall be given to insuring that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to
surfaces that are completely free of moisture as determined by sight or touch.

B. Ventilation: Affected areas shall be ventilated during paint application so that workers’ exposure to chemical substances will not exceed limits as established by ACGIH, or as required by a more stringent applicable regulation. Interior work zones having a volume of 10,000 cubic feet or less shall be ventilated at a minimum of 2 air exchanges per hour. Solvent vapors shall be exhausted outdoors, away from air intakes and workers. Return air inlets in the work zone shall be temporarily sealed before start of work until the coatings have dried.

C. Respirators: Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

D. First Coat: The first coat shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application.

E. Timing: Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleo resinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

F. Fillers: Concrete and masonry surface voids shall be filled; however, surface irregularities need not be completely filled. The dried filler shall be uniform and free of pinholes. Filler shall not be applied over caulking compound.

G. Cement-Emulsion Filler: Immediately before filler application, surfaces shall be dampened uniformly and thoroughly, with no free surface water visible, by several applications of potable water with a fog spray, allowing time between the sprayings for water to be absorbed. Cement-emulsion filler shall be scrubbed into the surface vigorously with a stiff-bristled brush having tampico or palmyra bristles not longer than 2-1/2 inches. At least 24 hours shall elapse before applying exterior emulsion paint over cement-emulsion filler. Surfaces shall be dampened lightly with a spray of potable water immediately prior to application of the subsequent paint coat.

H. Latex Filler: Latex filler, CID A-A-1500, shall be applied according to the manufacturer's instructions. Surface voids shall be filled and excess filler shall be removed from the surface with a rubber squeegee. The filler shall be allowed to dry, the length of time specified by the manufacturer, prior to applying successive coats of paint.

I. Ferrous-Metal Primer: Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than bituminous coatings prior to deterioration of the prepared surface. The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal
3.5 Cleaning

A. Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

3.6 Paint Schedule

<table>
<thead>
<tr>
<th>SURFACE</th>
<th>MPI SYSTEM</th>
<th>COAT</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Wood Trim</td>
<td>EXT 6.3H</td>
<td>Primer MPI #72</td>
<td>White</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First MPI #72</td>
<td>Courthouse Beige</td>
</tr>
<tr>
<td></td>
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<td>Second MPI #72</td>
<td>Courthouse Beige</td>
</tr>
<tr>
<td>Door and Frame</td>
<td>EXT 5.3C</td>
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</tr>
<tr>
<td></td>
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<td>Courthouse Beige</td>
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<tr>
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<td>Exterior Ferrous Piping and Ferrous Piping in Wet Well</td>
<td>EXT 5.1F</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>First MPI #108</td>
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<tr>
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<td></td>
<td>Third MPI #77</td>
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<td>Grab Bars</td>
<td>EXT 5.6D</td>
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<td></td>
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</tr>
<tr>
<td>4” Wide Concrete Strip Around Wet Well Hatches</td>
<td>EXT 3.2C</td>
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<td>Safety Yellow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First: As recommended by finish coat manufacturer</td>
<td>Safety Yellow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second MPI #82</td>
<td>Safety Yellow</td>
</tr>
<tr>
<td>Exterior Ferrous Electrical Conduit and Junction Boxes</td>
<td>EXT 5.3C</td>
<td>Primer MPI #101</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>First MPI #77</td>
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</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>Exterior Galvanized Electrical Conduit and Junction Boxes</td>
<td>EXT 5.3C</td>
<td>Primer MPI #101</td>
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<td>First MPI #77</td>
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<td></td>
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<tr>
<td>SURFACE</td>
<td>MPI SYSTEM</td>
<td>COAT</td>
<td>COLOR</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------------</td>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>Exterior Aluminum Electrical Conduit and Junction Boxes</td>
<td>EXT 5.4E</td>
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</tr>
<tr>
<td></td>
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<td></td>
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<td>Interior Wood</td>
<td>INT 6.3L</td>
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<tr>
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<td></td>
<td>First: As recommended by finish coat manufacturer</td>
<td>Safety Yellow</td>
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<td></td>
<td>Second MPI #82</td>
<td>Safety Yellow</td>
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<td>Interior Steel Items</td>
<td>EXT 5.1S</td>
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<td></td>
<td></td>
<td>First MPI #108</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Second MPI #108</td>
<td>Light Gray</td>
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<tr>
<td>Interior Ferrous Valves and Piping</td>
<td>EXT 5.1H</td>
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</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>Valve Hand Wheels, Chain Wheels, and Check Valve Cover and Arm</td>
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<td>Primer MPI #108</td>
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<td></td>
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<td>First MPI #72</td>
<td>Red</td>
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<tr>
<td>Pumps and Motors in Dry Well</td>
<td>EXT 5.1H</td>
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<td>Red</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First MPI#72</td>
<td>Light Gray</td>
</tr>
<tr>
<td>Pump Drive Shaft 6” Band at Ends</td>
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<td>First MPI #72</td>
<td>Light Gray</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second MPI #72</td>
<td>Safety Yellow</td>
</tr>
<tr>
<td>SURFACE</td>
<td>MPI SYSTEM</td>
<td>COAT</td>
<td>COLOR</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------------</td>
<td>-------------------------------------------</td>
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<td>Concrete Pump Bases</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td>Light Gray</td>
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<tr>
<td>Interior Ferrous Electrical Conduit and Junction Boxes</td>
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<td>Primer MPI #101</td>
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</tr>
<tr>
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<td>First MPI #77</td>
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<td>Interior Galvanized Electrical Conduit and Junction Boxes</td>
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<tr>
<td></td>
<td></td>
<td>Second MPI #77</td>
<td>Red</td>
</tr>
<tr>
<td>Interior Aluminum Electrical Conduit and Junction Boxes</td>
<td>EXT 5.4E</td>
<td>Primer MPI #80</td>
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<td></td>
<td></td>
<td>First MPI #77</td>
<td>Red</td>
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<tr>
<td></td>
<td></td>
<td>Second MPI #77</td>
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</tr>
<tr>
<td>Interior Non-Ferrous Electrical Conduit</td>
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<td>Primer: MPI #69</td>
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<tr>
<td></td>
<td></td>
<td>Second MPI #11</td>
<td>Red</td>
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<tr>
<td>Control Room Floor</td>
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<td>Primer: As recommended by finish coat manufacturer</td>
<td>Light Gray</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First: As recommended by finish coat manufacturer</td>
<td>Light Gray</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second MPI #82</td>
<td>Light Gray</td>
</tr>
</tbody>
</table>

END OF SECTION
Section 11307 – Factory Assembled Vacuum Stations

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing pre-fabricated Vacuum Collection Stations.

B. Related sections

01600 Materials and Equipment
11308 Factory Assembled Vacuum Pump Station Control Panel
15100 Vertical Extended Shaft Centrifugal Pumping Equipment
15150 Non-Clog Submersible Centrifugal Pumps and Drives

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Operations and Maintenance Manual in accordance with Section 01600.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)/ American Waterworks Association (AWWA)


2) ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings

C. American Society for Testing Materials (ASTM)


2) ASTM A48 Standard Specification for Gray Iron Castings


4) ASTM D4097-95A – Standard Specification for Contact Molded Glass Fiber Reinforced Thermoset Resin Corrosion Resistant Tanks

D. United States National Bureau of Standards (NBS)
1) NBS Voluntary Product Standard PS 15-69 – custom Contact Molded Reinforced Polyester Chemical Resistant Process Equipment

E. National Electrical Manufacturers Association (NEMA)

F. The Society for Protective Coatings (SSPC)

1) SSPC-SP6 Commercial Blast Cleaning

1.4 Description of Work

A. The extent of work under this section includes furnishing, pre-fabrication and factory testing of a complete and self-contained vacuum collection station mounted on structural steel skids or self-supporting tank saddles. The vacuum collection station equipment includes the vacuum pumps, collection tank, sewage pumps, all associated piping and electrical motor control panel to the point indicated on the equipment manufacturer’s drawings and as described in the equipment manufacturer’s scope of supply pricing document.

1.5 Related Work Specified Elsewhere

A. Installation of pre-fabricated vacuum station equipment. Connection of vacuum sewers and discharge force main. Connection of electrical power to the vacuum collection station.

1.6 Manufacturer’s Experience

A. The manufacturer of pre-fabricated station equipment and controls shall have a minimum of five years of experience in the design, manufacture and start-up of vacuum stations, and have at least five installations in service. Provide verification upon request.

2. Products

2.1 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Fiberglass Reinforced Plastic Collection Tank. Shall be constructed of laminated fiberglass suitable for continuous exposure to domestic sewage and incorporating the following:

A. The laminate comprising the structural tank shall consist of a smooth, nonporous, abrasion and corrosion-resistant barrier comprised of an inner surface, interior layer, and a structural layer. Interior and exterior finished surfaces shall be smooth.

B. Tank shall be of 0-90 deg. winding construction, or hand layup, and shall be in accordance with the following standards:

1) ASTM D3299 for filament wound tanks

C. The 0-90 deg. wind sequence over the corrosion barrier shall consist of the following layers starting with the innermost and shall be repeated until the required strength is achieved:

1) 90 deg. hoop wind – 60 degree end roving.
2) Chopped strand glass
3) 0 degree wind.

D. Flanged 150-pound conically gusseted inlet nozzles, outlet nozzles and bottom drain. Threaded nipples for all probes, gauge and miscellaneous fittings.

E. Flanged 24-inch minimum top access manway, bolted with gasket to prevent vacuum loss.


G. Accessories including lifting lugs, mounting blocks/brackets/cradles, and bolt down holes. The tank shall be mounted on dual saddles of adequate size to support the tank and complete volume of liquid. Saddles shall be constructed of galvanized or painted carbon steel and secured directly to concrete housekeeping aprons (where used) with stainless steel hardware. Paint used for painted carbon steel saddle coating shall be submitted for approval.

H. Each tank shall be furnished with required number and size of nozzles, man-ways and taps, as shown on Contract Drawings.

I. Each tank shall be supplied complete with sight glass and isolation valves as shown, indicating internal wastewater levels for the full diameter of the tank.

J. Tank shall be designed for a normal internal operating vacuum range of between 26 inches mercury vacuum and 16 inches mercury vacuum. Tank shall be field tested with air at an internal vacuum of 28 inches mercury vacuum. Tank shall be factory tested at an internal pressure of 5 psig with air for one hour without exhibiting signs of breakage or distress. Tank shall be suitable for an ambient temperature between 0 and 110 deg. F. Specific gravity of the sanitary wastewater is 1.0. Certified factory test results shall be delivered to the OWNER.

K. Tank shall be provided with piping connections and manways as shown on the Contract Drawings. Circumferential stiffening ribs, integral support saddles, support bracket, lifting lugs and hold down bracket locations shall be selected by the tank manufacturer to be compatible with the piping, control probes and manway locations shown on the Contract Drawings.

L. Piping connections shall be flanged and shall be of the size shown on the Contract
Drawings. Piping connections shall be gusseted and designed to withstand 1500 ft.-lbs. in bending and 2000 ft.-lbs. of torque. Flanges shall be drilled to ANSI 125 lb. standard. Full faced gaskets shall be provided for all openings. Pump suction connection inverts shall be as shown on the tank drawing—critical dimension.

M. Horizontal: Cylindrical style with hemispherical end caps.

N. Tank Characteristics Table:

1) Solution Handled – Domestic Sewage
2) Tank Configuration – Horizontal
3) Capacity – as shown on the Contract Drawings
4) Diameter – as shown on the Contract Drawings

O. Acceptable Manufacturers:

1) DuraTech Corporation
2) Augusta Fiberglass
3) Or Approved Equal

2.3 Vacuum Pumps

A. Vacuum pumps shall have operating parameters as follows (see Section 01000 – Special Provisions for details):

<table>
<thead>
<tr>
<th>No. of Vacuum Pumps</th>
<th>Motor Size (h.p.)</th>
<th>Free Air Displacement (cfm)</th>
<th>Manufacturer</th>
<th>Model No.</th>
</tr>
</thead>
</table>

B. The vacuum pump shall be driven directly by a standard C-face, F2 assembly, TEFC NEMA inverter duty electric motor through a shaft coupling. No belt drives shall be used. At no time can motor horsepower exceed nameplate ratings. Pump shall have an end (ultimate) vacuum of 23" Hg. (150 Torr) minimum at sea level (29.92" Hg barometer). Pump shall be capable of continuous operation.

C. The vacuum pump shall be air cooled with absolutely no water requirements.

D. Pump shall have a built-in anti-suck-back valve mounted at the pump inlet.

E. Vacuum pump shall be dry running—no sealing or lubricating oil shall be required in the pumping chamber.

F. Entire pump, motor, and exhaust box shall be shipped as one factory assembled and
tested unit mounted on vibration isolators and shall be mounted on the vacuum station
skid as shown on the Contract Drawings.

G. Each pump and motor shall be fitted with a name plate indicating model, serial
number, horsepower, voltages, amperages, speed, efficiency, insulation type, frame
number, locked rotor current, and enclosure.

H. Busch proprietary Aqua Coating shall be applied on internal wetted components.

I. Vacuum pump shall include acoustic enclosure, vibration isolators, vacuum relief
valve, internal discharge silencer, initial charge of gear oil.

J. The vacuum system manufacturer shall provide a manual condensate collection
system to collect condensate from the vacuum pump moisture separator, vacuum
pump exhaust piping, and the vacuum header assembly. Condensate shall also be
collected from the Mink pump exhaust box via a drain line specifically installed for
Aqseptence Group in Busch Mink vacuum pumps. The system operator will be
required to drain this system once a day during routine inspections and maintenance.

K. Vacuum Pump Accessories:

1) Pump shall have Solberg vacuum filters mounted at the pump inlet providing
moisture and particulate removal. Vacuum filters shall be Model STS-300C as
manufactured by Solberg Manufacturing or approved equal. Provide vacuum
releases on each side of the filter assembly allowing the filter to be removed,
serviced, and drained while the system is operating.

2) If the exhausts of two or more vacuum pumps manifold together each vacuum
pump exhaust shall be fitted with a resilient seated swing check valve to prevent
moisture from entering the pump exhaust box. Check valves shall be Golden
Anderson or approved equal.

2.4 Dry Pit Submersible Pumps

A. Furnish and install Dry Pit Submersible Pumping Units complete with all accessories,
controls and appurtenances as shown in the Contract Drawings and specified in
Section 15150 or as required for a complete operating system. Sewage pumps shall be
capable of operating with a vacuum system at maximum 20 inches of Mercury. Each
pumping unit shall be rated for continuous duty in accordance with the operating
conditions: (see Section 01000 –Special Provisions for details)

<table>
<thead>
<tr>
<th></th>
<th>Primary Condition</th>
<th>Secondary Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity (gpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Dynamic Head (Feet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Maximum Horsepower at Design Condition (bhp)

<table>
<thead>
<tr>
<th>Speed at Design Condition (rpm)</th>
<th>Shutoff head (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Horsepower</td>
<td>Speed (rpm)</td>
</tr>
<tr>
<td>Impeller Size (In.)</td>
<td></td>
</tr>
</tbody>
</table>

## 2.5 Horizontal Non-Clog Sewage Discharge Pumps

**A.** Furnish and install Non-Clog Sewage Discharge Pumping Units complete with all accessories, controls and appurtenances as shown in the Contract Drawings and specified in Section 15100 or as required for a complete operating system. Sewage pumps shall be capable of operating with a vacuum system at maximum 20 inches of Mercury. Each pumping unit shall be rated for continuous duty in accordance with the operating conditions: (see Section 01000 –Special Provisions for details)

<table>
<thead>
<tr>
<th></th>
<th>Primary Condition</th>
<th>Secondary Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity (gpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Dynamic Head (Feet)</td>
<td></td>
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<tr>
<td>Maximum Horsepower at Design Condition (bhp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed at Design Condition (rpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shutoff head (Feet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Horsepower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed (rpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impeller Size (In.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**B.** Impeller shall be 2-vaned, semi-open, non-clog of cast iron material, with integral pump-out vanes on the back shroud.
C. Pump shaft shall be sealed against leakage by a mechanical cartridge seal. Rotating and stationary seal faces shall be silicon carbide. Cage and spring, stainless steel; elastomers, viton.

D. Each of the mated surfaces shall be lapped to a flatness of three light bands (34.8 millionths of an inch), as measured by an optical flat and monochromatic light. The stationary seal seat shall be double floating so that faces will not lose alignment during periods of shock loads that will cause deflection, vibration, and axial movement of the pump shaft. The seal shall be lubricated with oil from a separate, oil-filled reservoir. The same oil shall not be lubricated both the shaft seal and shaft bearings. Seal must be removable and replaceable through the cover plate opening.

E. Entire rotating assembly, which includes bearings, shaft, seal and impeller shall be removed as a unit without disturbing pump volute or piping. Means shall be provided for external adjustment of the impeller to the wear place. The entire rotating assembly shall move as one unit to enable the clearances to be adjusted. Clearance adjustment by means of moving the shaft, thereby affecting the seal, shall not be acceptable.

F. The pump manufacturer shall confirm that their pumps are suitable for use in vacuum sewage installation.

G. Each pump and motor shall be fitted with a name plate indicating model, serial number, size, capacity, voltages, amperages, speed and other data.

H. Pumps shall also be fitted with a replaceable wear plate.

I. Acceptable pumps include ‘T’ Series self-priming industrial pumps as manufactured by the Gorman-Rupp Company of Mansfield, Ohio.

2.6 Vertical Dry-Pit Non-Clog Sewage Discharge Pumps

A. Furnish and install Non-Clog Sewage Discharge Pumping Units complete with all accessories, controls and appurtenances as shown in the Contract Drawings and specified in Section 15100 or as required for a complete operating system. Sewage pumps shall be capable of operating with a vacuum system at maximum 20 inches of Mercury. Each pumping unit shall be rated for continuous duty in accordance with the operating conditions: (see Section 01000 –Special Provisions for details)

<table>
<thead>
<tr>
<th></th>
<th>Primary Condition</th>
<th>Secondary Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity (gpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Dynamic Head (Feet)</td>
<td></td>
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<tr>
<td>Maximum Horsepower at Design Condition (bhp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed at Design Condition (rpm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. Each pump shall be equipped with enclosed, non-clog type, two port, close-grained gray iron impeller, statically and dynamically balanced capable of passing 3" diameter spheres. The impeller hub shall be accurately slip fitted and key driven to the pump shaft. The impeller shall be securely attached to the shaft by means of a locking washer and impeller screw of AISI-304 stainless steel. Pumps shall have an inspection opening in the discharge of the casing.

C. A backplate with deflector vanes constructed of ASTM A48 Class 30 Grey Iron shall be provided, including a single mechanical seal, John Crane Type 1 of material code BD80581. (Tungsten Carbide vs. Silicon Carbide). The design shall allow for continuous operation without the need for external flush water or venting.

D. The pump shaft shall be equipped with renewable stainless steel shaft sleeves.

E. The pump manufacturer shall confirm that their pumps are suitable for use in vacuum sewage installation.

F. Each pump shall be fitted with not less than 1" bore vacuum equalizing line. This line shall run from the discharge side of each pump to the vacuum sewage collection tank. Ball valves shall be installed at the connection to the pump and collection tank.

G. Each pump and motor shall be fitted with a name plate indicating model, serial number, size, capacity, voltages, amperages, speed and other data.

H. Pumps shall be supplied with a base, flexible shaft coupling and coupling guard.

2.7 Collection Station Piping

A. This item includes piping, valves, fittings, pipe supports, fixtures, drains and other work involved in providing a complete installation.

B. Vacuum collection station piping shall include all piping within the collection station skid, connecting piping to vacuum pumps, collection tank, vacuum sewer lines and force mains.

C. Except where noted otherwise, waste water, vacuum and drain lines 4" or larger shall be Sch. 80 PVC for exposed installations and ductile iron mechanical joint (ANSI A21.11, AWWA C111) for buried installations; fittings shall be flanged and mechanical joint (ANSI AS1.10, AWWA C110) as appropriate. Vacuum lines as well as other lines under 4" shall be Schedule 80 PVC, 304 Stainless Steel, Galvanized, or Schedule 40 black iron. Vacuum Pump exhaust piping to be stainless steel,
galvanized or black iron. These lines are not to be inter-connected without prior consent of vacuum system supplier. Building sanitary drains shall be PVC DWV pipe and fittings.

D. One eighth inch (1/8") thick Red Rubber gaskets shall be used on all flanges.

E. All fasteners supplied by AIRVAC for mating flanges, pipe supports and various component mounting shall be Zinc Coated carbon steel.

F. Piping shall be adequately supported to prevent sagging and vibration and to permit expansion, venting and drainage. Supports shall be situated to prevent the weight of piping and valves from bearing on the pumps.

G. All shut-off valves fitted within the collection station shall be flanged.

1) Valves (2” or 3”) Butterfly valves used on vacuum pump inlets to be epoxy coated, cast iron, semi-lug body with 316 SS iron disc suitable for continuous contact with domestic sewage.

2) Ball valves used on site tube, equalizing lines, and condensate drains shall be 1” “True Union type with screw thread ends and EPDM seals.

3) Guage and Instrument Isolation valves shall be ½” 316 stainless steel body ball valves with Teflon seats or ¼” chrome plated brass ball valves with Teflon seats and Viton seals.

H. Check valves fitted to the sewage discharge pumps shall be supplied with an external lever and weight to ensure positive closing. Cast iron check valves shall be of the 125 lb. bolted bonnet, horizontal swing renewable seat type. Check valves shall be fitted with Buna N soft seats, and be manufactured by Golden Andersen or approved equal.

I. Check valves for vacuum pumps shall be flapper swing type and be manufactured by Golden Anderson or approved equal.

J. Vacuum Gauges: On the collection tank or mounted to the wall a gauge manifold with a 0-30 inch mercury vacuum gauge dedicated to each vacuum sewer main shall be installed. An identical gauge shall be supplied for mounting on the collection tank. Gauges shall be not less than 4 ½” diameter and shall be positioned so that they may easily be viewed when operating the sewer isolating valves. It shall be the CONTRACTOR’s responsibility to install gauge connections at each vacuum sewer as shown on the equipment manufacturer’s equipment drawings. Tubing and gauge isolation valves shall be provided with the gauges by the equipment manufacturer. For protection of the gauges, they may be shipped in separate containers for site installation by the CONTRACTOR.

K. Electric actuated, resilient seated butterfly valve for emergency high-level lockout: This valve is to close in an emergency high liquid condition to prevent drawing raw sewage into the vacuum pumps. Valve to be epoxy coated, cast iron, semi-lug body with 316 SS disc suitable for continuous contact with domestic sewage. In event of emergency high liquid tank level or loss of power the actuator will close the valve within 15 seconds by battery backup. Acceptable manufacturers: Assured Automation
Series STL butterfly valves with Promation Engineering electric actuator, or equal.

L. Miscellaneous pipe, fittings, etc.

1) Piping between Vacuum Pump and Air/Moisture Separator: Pipe material shall be schedule 40 seamless type 304 stainless steel pipe with thread ends. Fittings shall be 150 lb rated 304 stainless steel, NPT thread.

2) Piping between Air/Moisture Separator and Vacuum Header: Pipe material shall be Sch. 80 PVC. Fittings shall be Sch. 80 PVC solvent welded or threaded fittings.

3) Vacuum header material: Pipe material shall be Sch. 80 PVC in the size shown on the Contract Drawings. Fittings shall also be Sch. 80 PVC.

4) Piping at Vacuum Pump Exhaust: Pipe material shall be schedule 40 seamless type 304 stainless steel pipe with thread ends. Fittings shall be 150 lb rated 304 stainless steel, screwed type.

5) Condensate Header and Condensate Collection Lines (when and where used): The equipment manufacture shall supply and pre-pipe the 4” condensate header attached to the vacuum pump skid frame, condensate drains from the air/moisture separator and each vacuum pump exhaust drip leg. The CONTRACTOR shall supply and install the 1” Condensate Return piping from the header to the collection tank as shown on the Contract Drawings. Materials shall be Schedule 40 PVC for solvent welding or screw thread joints.

6) Sewage Pump Vibration Isolators: On each sewage pump suction line, the equipment manufacturer shall install a 150 pound, 30 inch mercury rated, flanged, expansion joint of a Neoprene material with a single arch and galvanized ductile iron flanges as manufactured by Mercer Rubber Company or approved equal.

2.8 Level Controls

A. Manufacturer shall provide and install level controls to monitor collection tank levels and control pump operation.

B. Controls shall be intrinsically safe.

C. Controls shall provide a 4-20 mA dc HART compatible output.

D. Control supply voltage shall be 24VDC.

E. There are to be three separate level probes which will provide the following functions:

1) Ground

2) High Level Alarm

3) High Level Lock-Out
F. The control points shall be as shown on the Contract Drawings. Level probes shall be furnished with control cables of sufficient length to be routed directly to the control panel.

G. Approved Manufacturers:

1) Drexelbrook Universal IV Level System

2) Or Approved Equal

2.9 Level Controls – Alternate

A. Provide a continuous level sensor with 4-20 mA output for continuous level measurement of the sewage collection tank. Provide operator adjustable set points for start/stop of sewage pumps.

B. Provide two (2) point level sensors for “sewage high level alarm” and “sewage high-high level vacuum lockout alarm” conditions. Conduction type, direct acting level control to have form C contacts rated at 10 amps. Supply voltage shall be 120V with probes operating at 10K ohm sensitivity.

C. Typical is Drexelbrook, Universal III 509-75 Series, or approved equal.

2.10 Vacuum Tank Vacuum Monitoring

A. Vacuum tank vacuum level shall be continuously monitored and recorded via a 12-inch chart recorder located in the control panel.

B. Vacuum shall be monitored with a pressure transmitter measuring differential pressure and transmitting a linear 4 to 20 mA DC output for use in a standard 24VDC supply voltage system. The unit shall be loop powered.

C. The base unit shall be fully adjustable throughout the span limit. Addition of Smart electronics shall limit the calibration requirements to point entry of zero and span samples only.

D. Smart electronics shall also provide for setup via Hart Protocol.

E. All process-wetted parts of the instrument shall be Type 316 SS and the transmitter shall be protected by a gasket, weatherproof NEMA 4X enclosure, approved for use in hazardous locations and intrinsically safe.

F. Transmitter shall have ½-inch NPT thread process connection.

G. Model 1151DP as manufactured by Emerson/Rosemount or approved equal.

2.11 Alternate Vacuum Tank Monitoring and Vacuum Pump Control

A. Vacuum Level Transmitter – Supplied by the System Manufacturer and installed in the System Manufacturer’s Control Panel. The CONTRACTOR shall be required to connect System Manufacturer supplied tubing to the Collection Tank connection from
Control Panel as indicated on Contract Drawings. This transmitter shall control vacuum pump operation—start, stop, etc.—as well as interface with SCADA system. This transmitter shall be able to provide ‘real time’ vacuum information including providing alarm signals via SCADA or other means. SMC brand transmitter is typical.

2.12 Miscellaneous Control Devices

A. The vacuum tank, pump skid and vacuum pump skid shall be equipped with all required control devices wired to junction boxes for extension to the vacuum station control center.

B. Control devices shall include:

1) Tank pressure switches and pressure transmitters for vacuum pump controls. Pressure switches shall control vacuum pump operation including lead and lag pump on, pumps off and low vacuum set points. The pressure transmitters shall generate 4 to 20 mA signal to monitor vacuum level in the tank.

2) Tank liquid level conductance and capacitance probes for sewage pump controls, low and high water alarms, and vacuum lock-out.

3) Sewage pump seal and temperature sensors.

4) Vacuum pump temperature sensors.

5) Sewage and vacuum pump check valve limit switches.

6) Equalization valves.

7) Anti-cavitation needle valves.

2.13 Sump Valve

A. The lower floor of the collection station shall be sloped to fall towards a sump (see Contract Drawings).

B. One (1) 2” vacuum sewage interface valve complete with controller/sensor and check valve shall be so mounted to evacuate all floor drainage, etc. collected in the sump.

C. The sump valve shall be piped through a 2” manual shut-off valve to the main vacuum sewage collection tank.

2.14 Structural Steel Skid

A. The vacuum pumps and sewage pumps shall be rigidly mounted to raise structural steel platforms. The collection tank shall be self-supported by means of twin saddles which may bear directly on the building floor.

B. All structural steel shall conform to ASTM A-36/A-36M with minimum tensile strength 58,000 PSI.
C. The platform shall be so designed to support the pumps and associated piping with main support members adequately sized to bear loads applied by lifting the unit(s) at four (4) points on its perimeter. Cross members will be located to bear the loads applied by various components. All structural members to be joined by a minimum 1/4" fillet weld.

D. The entire top surface of the platform will be covered with steel deck plates. Where access to components is required, non-slip type safety floor plate shall be used. Lifting cleats will be attached at four (4) points along the platform perimeter to allow lifting by cable and spreader bars. Each cleat will be adequately sized to bear the load of the entire assembly. They will be fastened by bolts and are to be removed.

E. Painting: The entire platform will be prepared in accordance with SSPC-SP6 as detailed for commercial blasting. Paint and paint application shall be in accordance with Section 09000.

3. Execution

3.1 Installation

A. The CONTRACTOR shall install the vacuum system in accordance with the Contract Drawings and System Manufacturer instruction. The CONTRACTOR shall be responsible for reassembly of system components that are disassembled for shipment.

B. Install equipment with skilled mechanical erection labor in accordance with manufacturer’s instructions.

C. Provide and install all interconnecting equipment, piping, cable trays, and control and electrical wiring as required to provide an operable vacuum station in accordance with these specifications and the Contract Drawings.

D. Obtain manufacturer’s certifications on equipment as being installed, adjusted and approved satisfactory and completely ready for operation.

E. Furnish the OWNER with manufacturer’s certificates regarding equipment installation prior to Initial Mechanical Performance Test.

3.2 Quality Control

A. Factory Testing

1) The vacuum system manufacturer shall perform factory testing of the entire vacuum system to verify proper operation of the sewage pumps, vacuum pumps and control functions. The testing shall include interfacing with and testing of the Factory assembled vacuum pump station control panel as indicated in Section 11308.

2) The vacuum system manufacturer shall submit a certified factory test report documenting test results and successful completion of the testing.

3) The OWNER and CONTRACTOR reserve the right to witness factory testing of
the equipment.

B. Factory Representative

1) The CONTRACTOR will furnish a minimum of three weeks of representation from the System Manufacturer as follows:

(a) One week – Instruct the CONTRACTOR in installation and assembly of the System.

(b) One week – Assist the CONTRACTOR in placing the system into service and performing initial operational testing of the system.

(c) One week – Assist the CONTRACTOR in performing Final Acceptance Testing, perform equipment adjustments and testing, and instruct the OWNER’s personal in System Operation. Instruction shall include a minimum of 12-hours of hands-on operational instruction provided in increments suitable to the OWNER.

2) Each of the three visits will include a minimum of 40-hours of service by a System Manufacturer field engineer.

3) Further visits/instruction that may be required by the CONTRACTOR to demonstrate proper operation of the system will be at the CONTRACTOR’s expense.

C. System Start-up

1) Operational Testing shall be in accordance with the Manufacturer’s recommendations.

2) Final Acceptance Testing shall be in accordance with the Manufacturer’s recommendations.

END OF SECTION
Section 11308 – Factory Assembled Vacuum Pump Station Control Panel

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment for pre-wired control panels and electrical components provided on an AIRVAC skid mounted vacuum collection station.

B. The extent of work under this section includes furnishing, prewiring and factory and field testing of a complete self-contained control unit for monitoring of vacuum and fluid levels and cycling of pumps for a skid mounted vacuum station. The electrical equipment includes a control panel (MCP) level probes, and vacuum switches.

C. Related sections

01600 Materials and Equipment
11307 Factory Assembled Vacuum Stations
15100 Vertical Extended Shaft Centrifugal Pumping Equipment
15150 Non-Clog Submersible Centrifugal Pumps and Drives
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16120 Conductors and Cables
16130 Raceway and Fittings
16260 Motor Controllers

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Operations and Maintenance Manual in accordance with Section 01600.

C. Part numbers of components used on the drawings shall be highlighted.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. International Electrotechnical Commission (IEC)

C. Military Specification (MIL)

1) MIL-M-3971 Meters, Time Totalizing, Non-Hermetically Sealed Electrical

D. National Electrical Manufacturers Association (NEMA)

E. National Electric Code (NEC)
F. Underwriters Laboratories (UL)

1.4 Related Work Specified Elsewhere

A. Interconnection of sections of the split skid design. Routing of conduit and wires, termination at the MCP terminal strip and at the field junction box on the vacuum skid or tank skid. Interconnection shall include motor leads, switch leads, and probe connections.

1.5 Quality Assurance

A. Wiring and workmanship for the control components on the Vacuum Collection Skids will comply with the following regulations, standards, and publications:

1) Underwriters Laboratories

2) National Electric Code

B. All control components shall bear a UL Listing label in applicable categories.

1.6 Quality Control

A. All control panel components shall be of the most current and proven design. Specifications and Contract Drawings call attention to certain features but do not purport to cover all details entering into the design of the control system. The components provided by the System Supplier shall be compatible with the functions required and shall form a complete working system.

1.7 Manufacturer’s Experience

A. The manufacturer of pre-fabricated control panel shall have a minimum of five (5) years of experience in the design, manufacture and start-up of vacuum stations, and have at least five (5) installations in service. Provide verification upon request.

1.8 Electrical Drawings

A. Provide a submittal including complete electrical prints. These include but are not limited to panel layout and material list, power distribution, and control schematics, including required wire and conduit sizes.

2. Products

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.
2.2 General

A. Provide NEMA-12 enclosure panel with all relays, starters, disconnects, instruments, switches, indicating lights, terminal boards, and wiring to perform the following functions. Panel shall be wall mounted or floor mounted motor control center, based upon size required, and painted to color specifications provided.

1) Provide control and interlock contacts for operation of the sewage pumps in the automatic and manual modes.

2) Provide control and interlock contacts for operation of vacuum pumps in the automatic and manual modes.

3) Provide control and interlock contacts to assure delay of lag Vacuum and/or Sewage pump operation on initial power turn on.

4) Provide control and interlock contacts for operation of a High Level cutoff isolation valve.

5) Provide local visual alarm for low vacuum pressure, for high wastewater level in sewage receiver tank, and for high level lockout conditions. Provide for capability to test for pilot light operation.

6) Provide alarm signals for Remote Telemetry Unit.

7) Provide Vacuum Tank pressure indicating and recording receiver.

2.3 Disconnects

A. Provide main disconnect for incoming power.

B. Provide a separate disconnect for each Vacuum and Sewage Pump utilized. This may be an integral part of the starter detailed below.

C. One (1) power feed shall be provided to the enclosure and distributed to the disconnects via a distribution block or bus system.

D. Provide operating handle for disconnect switch mechanism providing indication and control of switch position with enclosure door open or closed, and capable of being locked in the OFF position with three padlocks. Construct and mount starters with disconnect switches in a NEMA Type 12 enclosure.

2.4 Motor Starters

A. General - except as otherwise indicated, provide motor starters and auxiliary components, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection shall be Installers' option.

B. Provide motor starters as indicated on the Contract Drawings sized for indicated loads.
They shall provide short circuit protection, and overload protection. Equip starters with electrical interlocks where indicated or required. Construct and mount starters in enclosure.

2.5 Level Controls

A. Provide RF level controls to continuously monitor collection tank levels. Level control shall be intrinsically safe, provide a 4-20 mA HART compatible output. Supply voltage shall be 24 VDC. Drexelbrook Universal IV Level System or approved equal.

2.6 Pressure Switches

A. Provide two (2) pressure switches with stainless steel bellows to monitor collection tank vacuum pressure. Differential pressure switch shall have one form C contact rated at 5 Amps. Switch shall have operating range of 30" vacuum to 10 PSI with adjustable differential of 0.4 to 6 PSI; Allen-Bradley 836P or approved equal.

2.7 Vacuum Chart Recorder

A. Supply panel mounted seven day chart recorder. Cast aluminum case to contain drive for 12" chart with range for 0 to 30" HG. Pen shall be removable fiber tip type. Chart to be replaceable through recorder door without opening the control enclosure door; Eurotherm Chessell, Model 392 or approved equal.

2.8 Pilot Devices

A. Selector switches shall be heavy duty, oil tight/watertight, 30mm LED type units. Switches shall have double-break silver contacts. Devices shall be installed using gaskets to maintain their NEMA 4 rating.

B. Push buttons shall be heavy duty, oil tight/watertight, 30mm units. Contacts shall be double break silver.

C. Pilot lights and illuminated selector switches shall be 30mm, heavy duty, LED type. Where contacts are used they shall be of double break silver type style.

D. Allen-Bradly, Square D, or Westinghouse are approved manufacturers of pilot devices.

2.9 Relays

A. Relays shall be heavy duty, general purpose type with 10 amp contacts. Relays shall have blade type terminals, which plug-in to a socket. ; Idec RH series relay or approved equal.

2.10 Elapsed Time Meters

A. Provide an hour meter for each pump for each of sewage and vacuum. The hour meter shall be 6 digit, 2" in diameter, sealed, conforming to MIL-M-3971, and operating at 120VAC. Veeder-Root 779516-201 or approved equal.
2.11 Terminal Blocks
   A. Terminal blocks shall be provided in the control panel for field wiring connections. All terminal blocks shall be labeled in accordance with the Contract Drawings, bearing the wire number connected. Provide IEC style, 600V terminals with current carrying capacity as required to carry full load without overheating.

2.12 Wiring
   A. All conductors and insulation shall be in accordance with Section 16120.
   B. Conduit shall be in accordance with Section 16130.

2.13 Control Configuration
   A. FUNCTIONAL DESCRIPTION OF CONTROL SWITCHES – The following is a basic description for a two-sewage pump, two vacuum pump station. System supplier shall adapt the general functional descriptions and operations as required to accommodate the actual quantity of pumps as indicated on the Contract Drawings.
   B. Control Power:
      1) Selector Switch 1 (SS1) - CONTROL POWER - provides 120V control power to the vacuum pump, sewage pump and alarm control circuits of the system.
      2) Panel Light (PL) CONTROL POWER ON - indicates that control power has been applied to the vacuum pump, sewage pump and alarm control circuits of the system.
   C. Vacuum Pump Controls:
      1) Selector Switch 2 (SS2) - VACUUM PUMP SELECT - determines the mode of operation for all vacuum pumps.
         (a) ALTERNATE - Vacuum Pump #1, and Vacuum Pump #2, will alternate as being the Duty Pump whenever the system requires more vacuum.
         (b) 1 - Vacuum Pump #1 will be the Lead Pump each time the system calls for more vacuum. Vacuum pump #2 will be the Standby Pump.
         (c) 2 - Vacuum Pump #2 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #1 will be the Standby Pump.
      2) Selector Switch 3 (SS3) - VACUUM PUMP #1 - determines the operation of Vacuum Pump #1.
         (a) HAND - hand - power is applied directly to Vacuum Pump #1.
         (b) OFF-Off - power is removed from Vacuum Pump #1.
         (c) AUTO-Automatic - Vacuum Pump #1 is controlled by the circuitry as
selected by the Vacuum Pump Select Switch, SS2.

3) PL-SS3 - indicates that power has been applied to Vacuum Pump #1.

4) Selector Switch 4 (SS4) - VACUUM PUMP #2 - determines the operation of Vacuum Pump #2.
   (a) HAND - hand - power is applied directly to Vacuum Pump #2.
   (b) OFF-Off - power is removed from Vacuum Pump #2.
   (c) AUTO-Automatic - Vacuum Pump #2 is controlled by the circuitry as selected by the Vacuum Pump Select Switch, SS2.

5) PL-SS4 - indicates that power has been applied to Vacuum Pump #2

6) ETM1 - indicates the total elapsed time that Vacuum Pump #1 has been on.

7) ETM2 - indicates the total elapsed time that Vacuum Pump #2 has been on.

D. Sewage Pump Controls:

1) SS5 - SEWAGE PUMP SELECT - determines the mode of operation for both sewage pumps.
   (a) Duty "1" - Sewage Pump #1 will be the Lead Pump each time the system requests to be pumped. Sewage Pump #2 will be the Lag Pump.
   (b) Alternate - Sewage Pump #1 and Sewage Pump #2 will alternate as being the Lead Pump whenever the system requests to be pumped.
   (c) Duty "2" - Sewage Pump #2 will be the Lead Pump each time the system requests to be pumped. Sewage Pump #1 will be the Lag Pump.

2) SS6 - SEWAGE PUMP #1 - determines the operation of Sewage Pump #1.
   (a) HAND - hand - power is applied directly to Sewage Pump #1.
   (b) OFF-Off - power is removed from Sewage Pump #1.
   (c) AUTO-Automatic - Sewage Pump #1 is controlled by the circuitry as selected by the Sewage Pump Select Switch, SS5.

3) PL-SS6 - indicates that power has been applied to Sewage Pump #1.

4) SS7 - SEWAGE PUMP #2 - determines the operation of Sewage Pump #2.
   (a) HAND - hand - power is applied directly to Sewage Pump #2.
   (b) OFF-Off - power is removed from Sewage Pump #2.
(c) AUTO-Automatic - Sewage Pump #2 is controlled by the circuitry as selected by the Sewage Pump Select Switch - SS5.

5) PL-SS7 - indicates that power has been applied to Sewage Pump #2.

6) ETM4 - indicates the total elapsed time that Sewage Pump #1 has been on.

7) ETM5 - indicates the total elapsed time that Sewage Pump #2 has been on.

E. Alarms:

1) PL1 - LOW VACUUM ALARM - indicates that system vacuum has dropped below 13 inches of mercury.

2) PL2 – EXCESSIVE RUN – indicates that vacuum pump operation has been requested for 30 minutes or more.

3) PL3 - SEWAGE HIGH LEVEL ALARM - indicates that the sewage in the Main Holding Tank has reached a high level condition.

4) PL4 - VACUUM PUMP LOCKOUT ALARM - indicates that the sewage level in the Main Holding Tank is high enough that there is risk of the sewage occupying areas not designed for its presence and damaging pumps.

5) PL5 – SEWAGE LOW LEVEL ALARM – indicates that the sewage level in the main holding tank has reached a low level condition.

6) PB1 - ALARM TEST - Turns on all Alarm Lights to assure proper working condition.


8) LOW VACUUM ALARM - the presence of low vacuum shall be indicated by the Low Vacuum Alarm Pilot Light, PL1. The Low Vacuum Alarm Pilot Light, PL1, shall remain on until the low vacuum condition is corrected.

9) EXCESSIVE RUN ALARM – the presence of excessive vacuum pump operation times shall be indicated by the Excessive Run Alarm Pilot Light, PL2. The Excessive Run Alarm Pilot Light, PL2, shall remain on until the excessive run condition is corrected.

10) SEWAGE HIGH LEVEL ALARM - the presence of a sewage high level shall be indicated by the Sewage High Level Alarm Light, PL3. The Sewage High Level Light, PL3, shall remain on until the high level condition is corrected.

11) VACUUM PUMP LOCKOUT ALARM - the presence of a Vacuum Pump Lockout Alarm shall be indicated by the Vacuum Pump Lockout Light, PL4. The Vacuum Pump Lockout Light, PL4, shall remain on until the condition is corrected.
2.14 System Configuration

A. Control Power: The Disconnect Switch shall supply line voltage to the Vacuum Pump and Sewage Pump starters, and to the Control Transformer, TRN1. TRN1 steps down the line voltage to 120V for control power.

1) 120V control power shall be provided through Control Power On Switch, SS1, to the Level Controls, LC1 through LC4, and to the Chart Recorder. Control power shall also be applied to the alarm section of the control circuitry and to the vacuum and sewage controls. Presence of control power to the vacuum pump, sewage pump and alarm circuitry shall be indicated by the Power On Pilot Light, PL-SS1.

B. A voltage monitor shall continuously monitor supply side voltage to the control panel. The voltage monitor shall provide protection for under voltage, power loss in any phase and voltage unbalance. The monitor shall have separately adjustable pickup and dropout ranges and maximum 6 second time delay of drop out. Activation of the voltage monitor shall disconnect power to the pumps. The voltage monitor shall automatically reset upon restoration of proper voltage. The monitor shall have one set of normally open contacts with a minimum 3 ampere continuous current rating for remote alarm function.

C. Vacuum Pump Controls - Automatic Operation: In automatic operation, the lead vacuum pump is controlled by Vacuum Switch, VS1. VS1 closes at 16 inches of mercury and opens at 22 inches of mercury. When VS1 closes, power is applied to CR1, which in turn applies power to the Vacuum Pump Alternator, ALT1.

1) In automatic operation, the lag vacuum pump is controlled by Vacuum Standby Pump Timer, TMR2. TMR2 starts with the closing of contacts on VS1. At the end of a time delay as determined by the setting on TMR2, its contacts close and feed a second input on the Vacuum Pump alternator, ALT1. TMR2 time delay shall be field adjustable from 1 second to 30 minutes, in 1 second intervals.

2) With the Vacuum Pump Select Switch, SS2, in the Duty "1" position, power is applied first to Vacuum Pump #1. With the Vacuum Pump Select Switch, SS2, in the Duty “2” position, power is applied first to Vacuum Pump #2. All vacuum pumps shall remain on until VS1 opens at 22 inches of mercury.

3) With the Vacuum Pump Select Switch, SS2, in the Alternate Position, power is applied to the Vacuum Pump Alternator ALT1. It determines which Vacuum pump will be the Duty Pump and Lag Pump. The end result is the switching of Duty Pump duty between Vacuum Pump #1 and #2.

4) When power is applied to Vacuum Pump #1 Contactor, an auxiliary switch applies power to the Vacuum Pump #1 Run light, PL-SS3, to an Elapsed Time Meter, ETM1, and to an Auxiliary Relay, C1AUX. The same mode of operation also applies to Vacuum Pump #2, PL-SS4, ETM2, C2AUX. All vacuum pumps are disabled from operation with the presence of a Sewage and Vacuum Pump Lockout Alarm. When power is supplied through the backup generator only one vacuum pump is allowed to run.
D. Vacuum Pump - "Off": In the "Off" position, operation of that associated vacuum pump is disabled.

E. Vacuum Pump - "Hand": In the "hand" position, power is applied directly to the associated vacuum pump; however the presence of a vacuum pump lockout alarm shall disable the vacuum pump operation.

F. Sewage Pump Controls - "Automatic" Operation: In "Automatic" operation, the sewage pumps are controlled by Level Control Relays, LC1, LC2 and the mode of operation as selected by the Sewage Pump Select Switch, SS5. When the level of sewage in the Main Holding Tank reaches the Lead Pump On Probe, Level #3, Level Control Relay LC1 is energized.

1) With the Sewage Pump Select Switch, SS5, in the Duty "1" position, power is applied directly to Sewage Pump #1. If Sewage Pump #1 cannot handle the level coming in, the level of sewage will continue to rise until it reaches the Lag Pump On Probe, Level #4. Level Control Relay LC2 will then energize and apply power directly to Sewage Pump #2. The Lead Pump, and if required, Lag Pump will remain on until the level of sewage in the Main Holding Tank drops below the Pump Off Probe, Level #2.

2) With the Sewage Pump Select Switch, SS5, in the Duty "2" position, power is applied directly to Sewage Pump #2. If Sewage Pump #2 cannot handle the level coming in, the level of sewage will continue to rise until it reaches the Lag Pump On Probe, Level #4. Level Control Relay LC2 will then energize and apply power directly to Sewage Pump #1. The Lead Pump, and if required, Lag Pump will remain on until the level of sewage in the Main Holding Tank drops below the Pump Off Probe, Level #2.

3) With Sewage Pump Select Switch, SS5, in the "Alternate" position, power is applied to the Sewage Pump Alternator, ALT2. Through a set of normally opened and normally closed contacts, ALT1 determines which sewage pump will be the Lead Pump and the Lag Pump. The end result is the switching of Lead Pump duty between Sewage Pump #1 and Sewage Pump #2.

4) When power is applied to Sewage Pump #1 starter an auxiliary switch applies power to the Sewage Pump #1 On Pilot Light, PL-SS6, to an Elapsed Time Meter, ETM4, and to an Auxiliary Relay, C4AUX. The same mode of operation also applies to Sewage Pump #2 On Pilot Light, PL-SS7, Elapsed Time Meter, ETM5, and Auxiliary Relay, C5AUX.

G. Sewage Pump - "Off": In the "Off" position, operation of that associated sewage pump is disabled.

H. Sewage Pump - "Hand": In the "hand" position, power is applied directly to the associated sewage pump.

I. Alarm - Low Vacuum: Vacuum Switch, VS2, closes at 13 inches of mercury indicating a low vacuum condition. The closing of VS2 energizes the Low Vacuum Alarm Control Relay, and applies power to the Low Vacuum Alarm Pilot Light, PL1.
J. Alarm - Sewage High Level: When the level of sewage in the Main Holding Tank reaches the High Level Probe, Level #5, Level Control Relay LC3 shall be energized and apply power to the Sewage High Level Control Relay and applies power to the Sewage High Level Alarm Light, PL2. This light shall remain on until the level of sewage in the Main Holding Tank drops below High Level Probe, Level #5.

K. Alarm - Vacuum Pump Lockout (High Level Lockout): When the sewage level in the Main Holding Tank reaches the High Level Lockout Probe, Level #7, Level Control Relay, LC4 is energized and applies power to the Vacuum Pump Lockout Relay. When it is energized, Vacuum Pumps #1 and #2 are disabled in both "Auto" and "Hand" operation. The Vacuum Pump Lockout will remain in effect until the sewage level is below the Reset Probe, Level #6.

L. Alarm – Low Level Alarm: When the sewage level in the Main Holding Tank reaches the Low Level Alarm Probe Level #8, the Sewage Low Level Alarm Light, PL5, shall be energized. This light shall remain on until the level of sewage in the Main Holding Tank rises about the Low Level Alarm Probe, Level #8.

M. Ground – A ground probe shall be provided as the common return path for the previously described levels probes.

3. **Execution**

3.1 Installation

A. Install the vacuum pump controls in accordance with the Contract Drawings and system manufacturer’s instructions. Refer to and coordinate with Section 11307.

3.2 Quality Control

A. Refer to Section 11307 for factory testing, factory requirements, and system start-up requirements.

END OF SECTION
Section 13329 – Sequence of Operation

1. **General.**

1.1 **Summary**

A. This section addresses work related to cooperation required between the OWNER and the CONTARCTOR to provide a complete and operational system. Sequences of operation contained herein are to be executed by the PLC under normal circumstances. If the PLC fails, the same sequence of operation is executed by the backup system.

B. **Related Sections**

   15100 Vertical Extended Shaft Centrifugal Pumping Equipment
   15150 Non-Clog Submersible Centrifugal Pumps and Drives
   15163 Variable Frequency Drives
   15170 Level, Pressure, and Intrusion Sensing Systems
   16260 Motor Controllers
   16310 Motor Control Panel

1.2 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. International Society of Automation (ISA) publications:

   1) S5.1 instrumentation symbols and identification.
   2) S5.4 instrument loop diagrams.
   3) S51.1 standard process instrumentation terminology.

1.3 **Sequences**

A. The following sequences of operation are presented to augment the drawings. The P& ID’s, Logic drawings, and the sequences of operation shall be considered complementary.

B. **Signal Transmission**

   1) Alarm status shall be communicated to the telemetry PLC / RTU, for the following:

      (a) Loss of Phase MCC Panel
      (b) Dry Well High Alarm
      (c) Wet Well High Alarm
(d) Generator Trouble
(e) Grinder FAIL
(f) Manhole #1 High Level
(g) Manhole #2 High Level
(h) Replace Battery
(i) Station Intrusion
(j) Surge Suppressor Fault
(k) Pump Trouble
(l) Wetwell Hi_Hi Level Alarm
(m) Wetwell Low Level Alarm
(n) FM Pressure Transmitters Disagree
(o) Generator Fault Detected
(p) Generator Low Fuel
(q) Power Monitor Truth Table - ATS Switch Failed
(r) Power Monitor Truth Table - ATS in Wrong Position
(s) Power Monitor Truth Table - Station Power Fail
(t) RTU Low Battery

2) Signal status shall be transmitted to the PLC for the following:

(a) Analog

(1) Level using Bubbler Signal
(2) Level Using Transducer
(3) VFD Speed Signal
(4) Pump 1 Amperage used for Self-Cleaning Wet wells

(b) Discrete

(1) Pump 1 Running
(2) Pump 2 Running
(3) Pump 3 Running (if applicable)
(4) Pump 4 Running (if applicable)
(5) Loss of Phase MCC Panel
(6) Dry Well High Alarm
(7) Wet Well High Alarm
(8) Generator Running
(9) Generator Trouble
(10) Generator Fault Detected
(11) Generator Low Fuel
(12) Bypass Pump Running
(13) Bypass Pump Trouble
(14) Bypass Pump Fault
(15) Bypass Pump Low Fuel
(16) Grinder Fail
(17) Grinder Running
(18) Manhole #1 High Level
(19) Manhole #2 High Level
(20) PCP in PLC Mode
(21) UPS Buffering
(22) UPS Ready
(23) UPS Replace Battery
(24) UPS Charging
(25) UPS Running on Battery
(26) UPS Status Good
(27) Station Intrusion
(28) Surge Suppressor Fault
(29) Rain Gauge Input
(30) Pump Trouble
(31) Wet Well Hi_Hi Level Alarm
(32) Wet Well Low Level Alarm
(33) FM Pressure Transmitters Disagree
(34) Cleaning in Progress (if applicable)
(35) Cleaning Mode Selected (if applicable)
(36) Cleaning Mode Timeout Alarm (if applicable)
(37) Cleaning Cycle Completed (if applicable)
(38) PLC On Battery Alarm
(39) Utility Power Available
(40) Generator supplying power
(41) Utility supplying power
(42) 0 = Bubbler  1 = Transducer
(43) Power Monitor Truth Table - ATS Switch Failed
(44) Power Monitor Truth Table - ATS in Wrong Position
(45) Power Monitor Truth Table - Station Power Fail
(46) ATS in Normal Position
(47) ATS in Emergency Position
(48) Gas Sensor
(49) Generator Power Available
(50) RTU Low Battery

C. Pumping Station Sequence of Operation and Control Description

   1) Procedure for Fixed Speed Automatic Operation – 2 pumps
(a) Description of Fixed Speed Automatic Operation

(1) Murphy Gauge. Use a Murphy Gauge as a backup level control system when PLC fails. Adjust level indicator-controller set points for desired wet well levels. Reading clockwise, the first set point is for pump shutdown (one or both pumps), the second is for lead pump start, and the third is for lag pump start. Adjustment is made with knobs on gauge front. Caution must be exercised so that set points are not jammed together; damage or malfunction may result.

(2) With Pump Circuit Breakers on.

(3) With the following switches set as noted:


   (ii) Hand-off-auto switch: (one for each pump): “auto” position.

(4) When the level indicator reaches the lead pump “on” set point, one pump shall start and continue to run until the level indicator lowers to the shutdown set point. On the next cycle the alternator circuit shall choose the other pump to start first, and so on. If the wet well level continues to rise, when the lag pump set point is reached the second pump shall start. Both pumps shall run until the shutdown set point is reached. A timer shall be used on lag so if both pumps are called to start at the same time, the lag shall only start after a delay of at least 10 seconds.

(5) Automatic Operation, one pump: Used when a pump has been taken out of service.

   (i) With the hand-off-auto switch for one pump in “off” position,

   (ii) For pump remaining in service, pump circuit breaker on and hand-off-auto switch in “auto.”

   (iii) With alternator switch selecting pump that is in service as lead pump.

   (iv) When level indicator reaches the lead pump set point the pump in service shall start. The controls shall work as when two pumps are in service, except that the pump in service will always be the lead pump (i.e. no alternating); there will be no lag pump. If, when setting up the controls for this mode of operation, the level indicator is above the lead pump set point, the pump shall operate when it reaches the lag set point.

2) Procedure for Fixed Speed Automatic Operation – 3 pumps

   (a) Murphy Gauge: Use a Murphy Gauge as a backup level control system when PLC fails. Adjust level indicator-controller set points for desired wet well levels. Reading clockwise, the first set point is for pump shut down (one or all pumps), the second is for lead pump start, the third is for first lag pump
start and the fourth is for second lag pump start. Adjustment is made with knobs on gauge front. Caution must be exercised so that set points are not jammed together; damage or malfunction may otherwise result.

(b) Pump Sequencing: The operation of a three-pump system is consistent with that of the two-pump system specified, with the following differences:

(1) Rather than alternating “Lead-Lag,” the system will sequence through “Lead-Lag1-Lag2” with the “Lead” role rotating among the three pumps, in order.

(2) The Murphy Gauge will have a second “Lag” contact.


(a) Murphy Gauge. Use a Murphy Gauge as a backup level control system when PLC fails. Adjust level indicator-controller set points for desired wet well levels. Reading clockwise, the first set point is for pump shut down (one or all pumps), the second is for lead pump low speed start, the third is for lead pump high speed start, the fourth is for second pump high speed start. Should 2-speed pumps be applied in a 3- pump facility, one additional high speed start set point contact shall be provided. Adjustment is made with knobs on gauge front. Caution must be exercised so that set points are not jammed together; damaged or malfunction may otherwise result.

(b) Pump Alternation and Sequencing: The starting alternation and sequencing of two-speed pumps shall be identical to that of single speed systems, except that the control panel shall automatically select “high speed” as levels rise.

(c) Pump Speed Control: As the level in the wet well rises, the lead pump shall start at “Low” speed and continue to run until the level indicator lowers to the shutdown set point. Upon the wet well level continuing to rise and reaching the second control “on” point, the lead pump shall shift to “High” speed. Upon the wet well level continuing to rise and reaching the third “on” point, the lag pump shall start at “High” speed.

4) Variable Frequency Drive Pump Stations – 2 Pumps

(a) Murphy Gauge. Use a Murphy Gauge as a backup level control system when PLC fails. Adjust level indicator-controller set points for desired wet well levels. Reading clockwise, the first set point is for pump shutdown (one or both pumps), the second is for lead pump start, and the third is for lag pump start. Adjustment is made with knobs on gauge front. Caution must be exercised so that set points are not jammed together; damage or malfunction may result.

(b) With Pump Circuit Breakers on.

(c) With the following switches set as noted:

(2) Hand-off-auto switch: (one for each pump): “auto” position.

(d) When the level indicator reaches the lead pump “on” set point, one pump shall start and continue to run until the level indicator lowers to the shutdown set point. On the next cycle the alternator circuit shall choose the other pump to start first, and so on. If the wet well level continues to rise, when the lag pump set point is reached the second pump shall start at full speed. Both pumps shall run until the shutdown set point is reached. A timer shall be used on lag so if both pumps are called to start at the same time, the lag shall only start after a delay of at least 10 seconds.

(e) Depending on the hydraulic conditions for the installation, pump speed shall be controlled by wet well level or by force main pressure. If the transmitter used to control pump speed fails, VFDs shall run at 60 Hz.

(f) Automatic Operation, one pump: Used when a pump has been taken out of service.

(1) With the hand-off-auto switch for one pump in “off” position,

(2) For pump remaining in service, pump circuit breaker on and hand-off-auto switch in “auto.”

(3) With alternator switch selecting pump that is in service as lead pump.

(4) When level indicator reaches the lead pump set point the pump in service shall start. The controls shall work as when two pumps are in service, except that the pump in service will always be the lead pump (i.e. no alternating); there will be no lag pump. If, when setting up the controls for this mode of operation, the level indicator is above the lead pump set point, the pump shall operate when it reaches the lag set point.

5) Variable Frequency Drive Pump Stations – 3 Pumps

(a) Murphy Gauge: Use a Murphy Gauge as a backup level control system when PLC fails. Adjust level indicator-controller set points for desired wet well levels. Reading clockwise, the first set point is for pump shut down (one or all pumps), the second is for lead pump start, the third is for first lag pump start and the fourth is for second lag pump start. Adjustment is made with knobs on gauge front. Caution must be exercised so that set points are not jammed together; damage or malfunction may otherwise result.

(b) Pump Sequencing: The operation of a three-pump system is consistent with that of the two-pump system specified, with the following differences:

(1) Rather than alternating “Lead-Lag,” the system will sequence through “Lead-Lag-Lag” with the “Lead” role rotating among the three pumps, in order.

(2) The Murphy Gauge will have a second “Lag” contact.
6) Manual Pump Operation

(a) With appropriate pump circuit breaker(s) “on”, and hand-off-auto switch(es) in the “hand” position.

(b) Pump shall run until hand-off-auto switch is turned “off” or until lockout occurs as specified in Section 16310.

1.4 Programming

A. The OWNER will provide the programming of the OWNER furnished PLC according to the type of pump station provided. The OWNER will provide the programming and adjustment to set points. The CONTRACTOR shall cooperate with the OWNER to acquire all required data and for the monitoring of the system.

B. The OWNER will prepare modifications to the software and reports, calculated points and events to provide for the new work. The new work will be integrated into the existing reporting system and include the following descriptions.

1.5 OWNER Furnished Equipment

A. The OWNER shall provide and install the PLC and telemetry equipment in the work. The CONTRACTOR shall be responsible for all wiring and terminations to the PLC. The OWNER shall program, run start and test the operation with the CONTRACTOR’S assistance. The CONTRACTOR shall be responsible for cooperating with the OWNER and coordinating the work as required to provide a complete and operational system.

2. Products. (Not Used)

3. Execution. (Not Used)

END OF SECTION
Section 14630 – Trolley and Runway Beam

1. **General**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing the component materials and functionality of the equipment that is used to handle remove or maintain equipment within the pump station such as pumps and valves. This system consists of a standard structural beam and plain or push manual trolley. Hoists for use with the trolley will be supplied by the OWNER for attachment to the trolley on an as-needed basis.

B. **Related Sections**

- 01600 Materials and Equipment
- 01650 Starting of System
- 05500 Miscellaneous Metals
- 09900 Painting

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Submit manufacturer catalog information for each trolley and support system including materials, weights, dimensions, and capacities.

2) Manufacturer’s Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

3) Shop Drawings indicating beam and trolley mounting details

4) Qualifications of Welders shall be submitted in accordance with the requirements of Section 05500

5) Operations and Maintenance Manual in accordance with Section 01600.

6) Test Load Certification as described in Section 3, D below.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be current effective edition.

B. **American Institute of Steel Construction (AISC)**

1) AISC 360 – Specification for Structural Steel Buildings

C. **American Welding Society (AWS)**

D. American Society of Mechanical Engineers (ASME)

1) ASME B30.16 – Overhead Hoists

E. Occupational Safety and Health Administration (OSHA)


2) OSHA 1910.179 - Overhead and Gantry Cranes.

2. Products.

2.1 System Design Criteria

A. Rated Capacity: As indicated on the Contract Drawings

2.2 Plain or Push Trolley

A. Trolley shall have machined cast iron or steel wheels with sealed bearings. Wheels shall be dual tread to fit either tapered or flat beam flanges within the range of adjustment.

B. Trolley shall have adjustable width to accommodate varying beam widths

C. Provide trolley with a clevis or bail with 2 by 1.25 inch clear opening for attachment of OWNER provided portable hoist.

2.3 Runway Beam

A. Total Length and Maximum Span: As shown on the Contract Drawings

B. Runway beam shall meet the requirements of AISC 360. Beam shall be sized for maximum loads as shown on the Contract Drawings with deflection not to exceed L/600 of the span.

C. Maximum Separation at beam joints 1/16 inch

D. Furnish trolley stops at each open end and where required to maintain clearances to equipment. Stops shall be bolted and movable and establish contact with the trolley frame.

E. Structural Supports (if required) shall be sized for live-load capacity plus 15 percent for hoist and trolley weight and 25 percent for impact.

3. Execution.

A. Verify that field dimensions are as indicated on Shop Drawings.
B. Install equipment according to manufacturer instructions and as indicated on Contract Drawings.

C. Inspection: Check trolley for smooth operation and excessive vibration and noise.

D. Testing:
   1) Test Load Certification:
      (a) Certification shall be provided by Professional Engineer licensed in the Commonwealth of Virginia
      (b) Comply with OSHA 1910.179.
      (c) Test in presence of OWNER

E. Equipment Acceptance:
   1) Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
   2) Make final adjustments to equipment under direction of manufacturer's representative.

F. Repair damaged coatings with material equal to the original coating.

G. CONTRACTOR shall supply OSHA compliant labels denoting the lifting beam capacity. Lifting beam capacity is noted on the Contract Drawings.

H. Demonstrate trolley operation and routine maintenance procedures to OWNER's personnel.

END OF SECTION
Section 15062 – Interior Pipe, Fittings, Valves, and Specialties

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing pipe, fittings, valves, hangers, supports, and specialties.

B. **Related sections**

01600 Materials and Equipment
01650 Starting of System
05500 Miscellaneous Metal Items
07900 Joint Sealants
09900 Painting

1.2 **Submittals**

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. The CONTRACTOR shall transmit from the Vendor to the OWNER, the pipe manufacturer’s certification of compliance with the applicable sections of the Specifications.

C. The CONTRACTOR shall coordinate all submittals with the related Vendor in a manner not to impede construction on individual projects.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. **American Water Works Association (AWWA)**

1) AWWA C110 Ductile Iron and Gray-Iron Fittings

2) AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

3) AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

4) AWWA C151 Ductile-Iron Pipe, Centrifugally Cast

5) AWWA C219 Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe

6) AWWA C500 Metal-Seated Gate Valves for Water Supply Service

7) AWWA C508 Swing-Check Valves for Waterworks Service, 2 In. through 24 In.
8) AWWA C509 Resilient-Seated Gate Valves for Water Supply Service

9) AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances

C. American Society for Testing and Materials (ASTM)

1) ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless


3) ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength

4) ASTM A530 Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe

5) ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts

6) ASTM A778 Standard Specification for Welded, Unannealed Austenitic Stainless-Steel Tubular Products

7) ASTM B32 Standard Specification for Solder Metal

8) ASTM B813 Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Pipe

9) ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

10) ASTM D2000 Standard Classification System for Rubber Products in Automotive Applications


13) ASTM D2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets

14) ASTM F412 Standard Terminology Relating to Plastic Piping Systems

D. American National Standards Institute (ANSI)

1) ANSI A21.10 Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids
2) ANSI B16.3 Fittings and Valve Packages

E. Combined ANSI/AWWA

1) AWWA C110/ANSI A21.10 – American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids


3) AWWA C150/ANSI A21.50-14 – Thickness Design of Ductile-Iron Pipe

F. American Society of Mechanical Engineers (ASME)

1) ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

2) ASME B16.42 Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300

3) ASME B40.100 Pressure Gauges and Gauge Attachments

G. American Society of Sanitary Engineers (ASSE)

1) ASSE-1011 Performance Requirements for Hose Connected Vacuum Breakers

H. Virginia Uniform Statewide Building Code

I. National Science Foundation (NSF) International

1) NSF 61 Drinking Water System Components – Health Effects

J. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):

1) MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture

2) MSS SP-69 - Pipe Hangers and Supports - Selection and Application

2. Products

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Materials

A. Pipe shall be supplied in lengths not in excess of 20 feet. Pipe shall be designed to be installed in accordance with the Contract Drawings.
B. Exterior surfaces of pipe, fittings and valves identified to receive final painting shall be in accordance with Section 09900.

C. Ductile iron pipe shall meet the following requirements:

1) Flanged ductile iron pipe shall conform to current ANSI/AWWA C151/A21.51 Special Thickness Class 52 with factory-applied, screwed, long hub flanges, except as otherwise specified hereinafter or shown on the Contract Drawings. Flanges shall be faced and drilled after being screwed onto the pipe, with flanges true 90° with the pipe axis; and shall be flush with end of pipe. Minimum factory hydrostatic test pressure shall be 500 psi. Piping and fittings within a sewage pumping station shall be flanged ductile iron. Flanged pipe that leaks will be rejected.

2) Fittings shall be ductile iron as specified herein. Flanges and flanged fittings shall be flat face ASME B16.42, 150-lb flanges and shall conform to ANSI A21.10 for 250 psi pressure rating. Full face type 1/16-inch thick fiber reinforced rubber ring gaskets shall conform to ASTM D2000. Flanged pipe shall be tested prior to delivery to the site.

3) All pipe and fittings shall be ceramic epoxy interior lined.

4) Bolts and nuts on flanged joint pipe fittings shall be 316 grade stainless steel and conform to ANSI B16.1 for Class 250.

D. Polyvinyl chloride PVC pipe

1) Pipe shall be schedule 80 and conform to ASTM D1785. All fittings shall be socket welded conforming to ASTM D2467 or threaded fittings. Plastic piping joints and solvent cements shall conform to ASTM D2564. Installation of joints shall conform to ASTM D2855 and ASTM F412. All joints shall be primed and prepared in accordance with the referenced standards.

E. Water Systems Piping (Potable Service)

1) All products and materials provided for potable water service shall be certified “lead-free” by an ANSI certified, third party independent organization. The term “lead-free” shall refer to the wetted surface of pipes, fittings, and fixtures in potable water systems that have a weighted average lead content less than or equal to 0.25 percent per the Safe Drinking Water Act (Section 1417) amended 1-4-2011 and other equivalent state regulations.

2) Piping shall be Type "L" copper with cast bronze or wrought copper, solder type fittings for above grade and Type "K" for where buried. Solder shall be Alloy 95TA (95 percent Tin, 5 percent Antimony), ASTM B32. No solder containing lead shall be utilized on the project. Flux shall comply with ASTM B813 and NSF 61.
F. Stainless Steel Pipe

1) Volute Vent: Vent pipe from volute to valve shall be stainless steel, downstream of the valve the pipe shall be PVC.

2) Sump Pump: Discharge pipe from sump pump to first valve shall be stainless steel, downstream of the valve the pipe shall be PVC.

3) Stainless steel pipe and fittings shall be fabricated from stainless steel sheet and conform to ASTM A778 Type 316L. Carbon content of Type 316L material shall be 0.03 percent maximum. Finish shall be No. 1 or No. 2B.

4) Pipe shall be die-formed or rolled true to dimension and round. Tolerances for length, inside and outside diameter and straightness shall conform to ASTM A530. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe. Ends of pipe and fittings shall be perpendicular to the longitudinal axis. Longitudinal seams on pipe and fittings shall be welded by either the tungsten gas or the metallic-gas method. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16-in. All pieces shall be marked with gauge and type of stainless steel and with the initials of the inspector marked on the inside of each piece, at each end.

5) Fittings shall be smooth curve type.

6) Pipe shall be threaded

G. Ball Valves for Small Diameter Piping (less than 4 inches)

1) Shall be stainless steel and rated for 150 lb steam working pressure.

2) Shall be two-piece, quarter-turn, full port ball type with solder or threaded ends and shall have stainless steel lever handles.

H. Resilient Seated Gate Valves – 4-inch to 12-inch

1) Gate valves with 4-inch to 12-inch diameters shall be resilient seated, manufactured to meet or exceed the requirements of AWWA C509 or its latest revision, and in accordance with the following specifications. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve. Working pressure shall be 200 psi and test pressure shall be 400 psi.

2) The valves are to be non-rising stem with the stem made of cast, forged, or rolled bronze shown in AWWA C509. Two stem seals shall be provided and shall be of the O-ring type, one above and one below the thrust collar.

3) The sealing mechanism shall consist of a cast iron gate having a vulcanized synthetic rubber coating, or natural rubber seat ring. The resilient sealing mechanism shall provide zero leakage at the water working pressure when installed with the line flow in either direction.

4) The valve body, bonnet, and bonnet cover shall be cast iron ASTM A126, Class
B. All ferrous surfaces, inside and outside, shall have a fusion-bonded epoxy coating. A hand wheel or wrench nut shall be provided for operating the valve. All valves are to be tested in strict accordance with AWWA C509.

5) Where indicated on the Contract Drawings or necessary due to location, size, or inaccessibility, chain wheel operators shall be furnished with the valves. Such operators shall be designed with adequate strength and leverage for the valves with which they are supplied, and to provide for easy operation of the valve. Chains for valve operators shall be galvanized.

6) Where required, gate valves shall be provided with a box cast into the concrete slab and a box cover. Length of box shall equal slab thickness. Box cover opening shall be for valve stem and nut. Valve wrenches and extension stems shall be provided by the manufacturer to actuate the valves.

I. Swing Check Valves

1) General. Swing check valves shall be iron bodied, bronze mounted, full opening swing type. Valve clapper shall swing completely clear of the waterway when valve is full open, permitting a “full flow” through the valve equal to the nominal pipe diameter. They shall comply with AWWA Standard C-508 latest revision.

2) Rating. Swing check valves shall be rated at 175 psi water working pressure, 350 psi hydrostatic test for structural soundness (sizes 2-inch through 12-inch) and 150 psi water working pressure, 300 psi hydrostatic test (sizes 14-inch through 30-inch). Seat tightness at rated working pressure shall be in accordance with values shown in AWWA C500 for gate valves and fully conform to AWWA C508.

3) End Configurations. Swing check valves shall be furnished with ANSI B16.1 Class 150 flanged end connections.

4) Materials

(a) All cast iron shall conform to ASTM A126 Class B. Castings shall be clean and sound without defects that will impair their service. No plugging or welding of such defects will be allowed.

(b) Clappers shall be all Bronze for 2-inch and 3-inch valves and cast iron, rubber faced for 4-inch and larger. When specified, neoprene bronze facing shall be furnished in place of rubber facing.

(c) Hinge pins shall be 18-8 Stainless Steel rotating in bronze plugs

(d) Bolts shall be electro-zinc plated steel with hex heads and hex nuts in accordance with ASTM A307 and A563, respectively.

5) Design

(a) Swing check valves shall be constructed to permit top entry for complete removal of internal components without removing the valve from the line.
(b) Glands shall be O-rings for 2-inch through 12-inch sizes and conventional for 14-inch through 30-inch sizes.

c) When specified, for application conditions of rapid flow reversal or vertical installation, swing check valves shall be equipped with adjustable outside lever and weight to accomplish faster closing and to minimize slamming effect.

d) Bosses shall be provided on swing check valves which may be tapped for draining or used for bypass. When tapping is required, boss designation and size of tap shall be stated.

e) All valves, 14-inch and larger, shall have extended hinge pins for future addition of levers and springs if required. Valves shall be suitable for installation in either horizontal or vertical position. Increasing swing check valves shall be provided in accordance with the provisions of this specification and where designated on the Contract Drawings.

J. CPVC Ball Check Valve

1) General. Ball check valves shall be used for sump pump and air relief per the Contract Drawings. Double union ends shall be provided to release the valve body for maintenance.

2) Rating. Maximum operating pressure of 150 psi.

3) End Configurations. NPT threaded ends.

4) Materials. All CPVC with EPDM seal and O-ring.

K. Unions

1) Unions on ferrous pipe, two inches in diameter and smaller, shall be 150-pound class malleable iron, zinc coated. Unions on water pipe 2-1/2 inches in diameter and larger shall be flange pattern, 150-pound class, malleable iron zinc coated. Gaskets for flanged unions shall be of the best quality fiber, plastic, or leather. Unions shall not be concealed in walls, ceilings, or partitions.

2) Unions for PVC pipe shall be solvent welded schedule 80 in accordance with ASTM D2467.

L. Pipe couplings for ductile iron and steel pipe

1) Type: AWWA C219, bolted-gasketed sleeve type. Components:

   a) Steel middle ring.

   b) Two steel followers.

   c) Two rubber-compound wedge shaped gaskets suitable for service intended.
(d) Stainless steel bolts.

2) Exterior Finish:

   (a) Exposed Service: Factory-applied primer; in accordance with Section 09900 for service condition.

   (b) Buried Service: Factory-applied epoxy coating suitable for buried service.

3) Interior Finish: Factory-applied ceramic epoxy coating.

M. Pipe Sleeves

1) Materials: Sleeves for ventilation pipes shall be PVC, all other sleeves shall be ductile iron.

2) Integral waterstop collar.

3) Size:

   (a) Diameter: Large enough to allow for mechanical type seal installation.

   (b) Length: Flush with both faces of wall or floor where installed, unless otherwise indicated.

N. Non-mechanical Type Seals

1) Stuff opening between pipe and sleeve with glass fiber or mineral wool, non-combustible.

2) Caulk opening with sealant; in accordance with Section 07900

O. Mechanical Type Seal

1) Design: Modular mechanical type, consisting of interlocking synthetic rubber links, shaped to fill the annular space between the pipe and sleeve.

2) Size: As recommended by manufacturer based on pipe size and opening size.

3) Sealing Element: EPDM rubber.

4) Pressure Plate: Glass reinforced nylon plastic

5) Bolts and Nuts: 304 stainless steel

P. Flanged Expansion Joint

1) Expansion joint shall be multi-layer molded rubber joint with steel flanges compatible with ANSI B16.1 Class 150 pipe flanges.

2) Expansion joint shall be designed to permit axial compression or elongation and
lateral and angular movement.

3) Elastomer shall be Neoprene, Hypalon, or EPDM.

Q. Painting

1) The inside and outside of all valves, together with the working parts except bronze and machined surfaces shall be coated in accordance with AWWA standards.

R. Marking

1) Marking shall be in accordance with AWWA C508 and shall include size, working pressure, and cast arrow to indicate direction of flow, name of manufacturer, and year of manufacture.

S. Pipe Supports and Hangers

1) Furnish all labor, materials, equipment and incidentals and install a complete system of pipe hangers, supports, concrete inserts and anchor bolts including all metallic hanging and supporting devices for supporting non-buried piping as shown on the Contract Drawings and as specified herein.

2) The absence of pipe supports and details on the Contract Drawings shall not relieve the CONTRACTOR of the responsibility for providing them. Pipe supports indicated on the Contract Drawings are shown only to convey the intent of the design for a particular location and are not intended to represent a complete system.

3) Engage the services of an independent registered professional engineer ordinarily engaged in the business of pipe support systems analysis, to analyze system piping and service conditions and to develop a detailed support system, specific to the piping material, pipe joints, valves and piping appurtenances proposed for use.

4) Provide in accordance with hanger and support sections below.

T. Single Pipe Hangers

1) Single pipes shall be supported by hangers suspended by hanger rods from structural steel members, concrete ceilings, bottom of trapeze hangers and wall-mounted steel angle brackets.

2) Except as otherwise specified herein, pipe hangers shall be steel, of the adjustable clevis type.

3) Where pipes are near walls, beams, columns, etc, and located an excessive distance from ceilings or underside of beams, welded steel wall brackets shall be used for hanging pipe. Where single pipes rest on top of bracket pipe supports, attachments shall meet requirements as specified under multiple pipe hangers.
U. Multiple Pipe Hangers

1) Suspended multiple pipes, running parallel in the same horizontal plane, which are adjacent to each other shall be suspended by trapeze type hangers or wall brackets. Trapeze hangers shall consist of galvanized structural steel channel supported from galvanized threaded rod or attached to concrete walls, columns or structural steel support members as required to meet the intent of this Section. Rods, concrete inserts, "C" clamps, beam clamps, welded beam attachments and expansion shields shall be as specified in under Single Pipe Hangers.

2) Except as otherwise specified herein pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs. Material of construction shall be galvanized steel. Chair "U" bolts shall be tightened to allow freedom of movement for normal expansion and contraction except where pipe must be anchored to control direction of movement or act as a thrust anchor.

V. Single and Multiple Pipe Supports

1) Single pipes located in a horizontal plane close to the floor shall be supported by one of the methods as shown on the Contract Drawings and as specified herein.

2) Pipes 3 inches in diameter and larger shall be supported by adjustable stanchions. Stanchions shall provide at least 4-in adjustment and be flange mounted to floor.

3) Pipes less than 3 inches in diameter shall be held in position by supports fabricated from steel "C" channel, welded post base and pipe clamps. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected together by horizontal member of sufficient load capacity to support pipe. Wherever possible supports shall be fastened to nearby walls or other structural member to provide horizontal rigidity. More than one pipe may be supported from a common fabricated support.

4) Where shown on the Contract Drawings, pipe shall be supported using concrete anchor posts. Pipe shall be securely fastened to the posts using suitable metal straps as required and as approved.

W. Base Anchor Support

1) Where pipes change direction from horizontal to vertical via a bend, a welded or cast base bend support shall be installed at the bend to carry the load. The base bend shall be fastened to the floor, pipe stanchion, or concrete pedestal using expansion anchors or other method as approved by the OWNER.

2) Where shown on the Contract Drawings, pipe bends shall be supported using concrete anchor posts. Pipes shall be securely fastened to the concrete supports with suitable metal bands as required and approved by the OWNER. A felt insert shall be used to isolate the piping from the poured concrete.

X. Vertical Pipe Supports. Where vertical pipes are not supported by a metal framing system as specified under Special Supports, they shall be supported in one of the following methods.
1) For pipes ¼ inches to 2 inches in diameter, an extension hanger ring shall be provided with an extension rod and hanger flange. The rod diameter shall be as recommended by the manufacturer for the type of pipe to be supported. The hanger ring shall be steel or PVC clad depending on the supported pipe. The anchor flange shall be galvanized malleable iron.

2) For pipes equal to or greater than 2 inches in diameter extended pipe clamps may be used. The hanger shall be attached to concrete structures using double expansion shields, or to steel support members using welding lugs.

3) Pipe riser clamps shall be used to support all vertical pipes extending through floor slabs. Riser clamps shall be steel. Copper clad or PVC coated clamps shall be used on copper pipes. Insulation shall be removed from insulated pipes prior to installing riser clamps. Insulation shall not be damaged by clamp installation.

4) Unless otherwise specified, shown, or specifically approved by the OWNER, vertical runs exceeding 12 feet shall be supported by base elbows/tees, clamps, brackets, wall rests and pipe collars, all located as required to ensure a rigid installation.

Y. Special Supports

1) Pipe supports shall be provided for closely spaced vertical piping systems required to provide a rigid installation. The interval of vertical support spacing shall be as specified, but in no case shall vertical interval exceed 10 feet. The support system shall consist of a framework suitably anchored to floors, ceilings or roofs.

2) Vertical and horizontal supporting members shall be U shaped channels. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps. All components shall be of steel.

3) For piping 3 inches and smaller, the framework shall be manufactured metal framing system. For piping larger than 3 inches, the support frame shall be fabricated from structural steel shapes and secured through the use of expansion anchors.

4) The assemblies shall be furnished complete with all nuts, bolts and fittings required for a complete assembly including end caps for all manufactured metal framing system members.

5) The design of each individual framing system shall be the responsibility of the CONTRACTOR. Shop drawings, as specified above shall be submitted and shall show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached.

6) Supports not otherwise described in this Section shall be fabricated or constructed from standard structural steel shapes in accordance with applicable provisions of Section 05500, or manufactured metal framing system; have anchor hardware similar to items previously specified herein, shall meet the minimum requirements.
listed below and be subject to the approval of the OWNER.

7) Pipe support systems shall meet all requirements of this Section and all related Sections.

8) Complete design details of the pipe support system and system components shall be submitted for review and approval. No hanger or support shall be installed without the written approval of the OWNER.

9) The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.

3. Execution.

3.1 CONTRACTOR responsibilities during installation.

A. Install within the project site all materials and incidentals including ductile iron pipe and restrained joint ductile iron pipe and fittings for buried and exposed force mains, complete, as shown on the Contract Drawings.

B. Install all materials and incidentals required to install push-on joint or restrained joint ductile iron pipe, complete as shown on respective Contract Drawings and as specified herein.

C. Install all materials and incidentals required to install flanged joint ductile iron pipe, valves and fittings, complete, as shown on the Contract Drawings.

D. The CONTRACTOR shall coordinate all deliveries with the related vendor(s) in a manner not to impede construction.

3.2 Handling Pipe, Valves, and Fittings – per AWWA C600

A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe, valves and fittings shall not be dropped. All material shall be examined before installation, and no piece shall be installed that is found to be defective. Any damage to the coatings shall be repaired as directed by the OWNER.

B. All pipe and fittings shall be subjected to a careful inspection and hammer test just prior to being installed.

C. If any defective pipe is discovered, after it has been installed, it shall be removed and replaced with new pipe in a satisfactory manner at no additional expense to the OWNER.

D. The CONTRACTOR shall install the pipe true and plumb and no “springing” of pipe during the installation shall be allowed.

E. No field welding of ductile iron pipe shall be allowed.
3.3 Testing

A. Hydrostatic pressure and leakage test shall conform with Section 4 of AWWA C600 Specification, with the exception that the CONTRACTOR shall furnish all gauges, meters, pressure pumps, and other equipment needed to test the line. Allowable leakage for flanged pipe shall be zero.

B. Allowable leakage in pipe shall be: \[ L = \frac{SD\sqrt{P}}{133,200} \]

1) \( L \) = Allowable leakage in gallons per hour
2) \( S \) = Length of pipe, in feet
3) \( D \) = Nominal diameter of pipe, in inches
4) \( P \) = Average test pressure, during test, in pounds per square inch, gage

C. The pressure required for the field hydrostatic pressure test shall be 50% above the normal working pressure, but not less than 150 psi. The CONTRACTOR shall provide temporary plugs and blocking necessary to maintain the required test pressure. Corporation cocks at least ¾-inches in diameter, pipe riser and angle globe valves shall be provided at each pipe dead-end in order to bleed air from the line. Duration of pressure test shall be at least 24 hours. The cost of these items shall be included as a part of testing.

D. The leakage test shall be a separate test at the maximum operating pressure, as determined by the OWNER, following the pressure test; and shall be of not less than two hours duration. All leaks evident at the surface shall be repaired, and leakage eliminated regardless of total leakage as shown by test. Lines which fail to pass tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves and accessories shall be removed and replaced with new. The pipe lines shall be tested in such sections as may be directed by the OWNER by shutting valves or installing temporary plugs as required. The line shall be filled with water, and all air removed; and the test pressure shall be maintained in the pipe +/- 5 percent for the entire test period by means of a pump to be furnished by the CONTRACTOR. Accurate means shall be provided for measuring the water required to maintain this pressure. The amount of make-up water required is a measure of the leakage.

3.4 Surface Preparation and Painting

A. All piping, fittings and valves exposed to view shall be left unpainted from manufacturer and receive paint in accordance with Section 09900.

B. It shall be part of the work of this Section for the CONTRACTOR to assist, as required, the OWNER in identifying pipe contents, direction of flow, and all else required for proper marking of pipes.
Section 15100 – Vertical Extended Shaft Centrifugal Pumping Equipment

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing centrifugal type sewage pumps including motors, bearings and shafting, associated testing and sump pump.

B. Related Sections:

01000 Special Provisions
01600 Materials and Equipment
01650 Starting of System
09900 Painting
13329 Sequence of Operation
15163 Variable Frequency Drives
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16260 Motor Controllers
16310 Motor Control Panel

1.2 Submittals

A. Submit shop drawings and manufacturer’s data in accordance with the provisions of Section I, General Provisions, and Section 01600 – Materials and Equipment.

1) Certified performance curves in accordance with Hydraulic Institute Standards sign and sealed by the manufacturer’s licensed professional engineer.

2) Certified copies of results of hydrostatic test report.

3) Setting plans which shall include:

   (a) Anchor bolt layout and bolt dimensions.

   (b) Outline dimensions and weights of pumps, and control enclosures.

4) Pumps: Submittal Data and drawings shall include:

   (a) Manufacturer, type, and model number.

   (b) Assembly drawing, nomenclature and material list, O&M manual, and parts list.

   (c) Impeller type, diameter, sphere size passing, number of vanes and identification number.

   (d) Complete motor performance data including: HP rating, full load current, efficiency, voltage/phase/ frequency.
(c) Complete performance curve(s) showing full range (shutoff to run-out) head vs. capacity, NPSHR, hydraulic efficiency, motor active (KW) input power, and shaft power (BHP).

(f) The manufacturer shall indicate, by arrows to points on the flow versus head in feet of water curves, the limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall meet the hydraulic performance requirements of the proposed system.

(g) A copy of the system head curves and recommend pump performance curves are included in Section 01000 - Special Provisions. The system head curves include high and low head conditions with appropriate friction factors. The system head curves shall be plotted on the CONTRACTOR’S proposed pump curve and submitted for review.

5) Location and description of Service Centers and spare parts stock.

6) Torsional analysis of intermediate shafting.

7) Bearing life projection and warranty at the specified operating condition.

8) Operations and Maintenance Manual in accordance with Section 01600.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The referenced publications shall be the current effective edition.

B. Hydraulic Institute (HI)

C. American Society for Testing and Materials (ASTM)
   1) ASTM A48 Standard Specification for Gray Iron Castings
   2) ASTM A470 Standard Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts

D. American Iron and Steel Institute (AISI)

E. American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI)
   1) B16.1 Gray Iron Pipe Flanges and Flanged Fittings

F. National Electrical Manufacturers Association (NEMA)

G. Institute of Electrical and Electronics Engineers (IEEE)
H. National Electric Code (NEC)

I. American Bearing Manufacturers Association (ABMA)

2. Products

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Pump Performance

A. The pumps shall be suitable for pumping raw sewage and shall be designated and fully guaranteed for this use. The fluid temperature shall be from 40 degrees to 104 degrees F.

B. Sewage pumps shall be vertical, non-clog centrifugal wastewater pumps as shown on Contract Drawings with operating parameters as follows (see section 01000 - Special Provisions for details):

<table>
<thead>
<tr>
<th></th>
<th>Primary Condition</th>
<th>Secondary Condition</th>
</tr>
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<tbody>
<tr>
<td>Capacity (gpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Dynamic Head (Feet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Horsepower at Design Condition (bhp)</td>
<td></td>
<td></td>
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<tr>
<td>Speed at Design Condition (rpm)</td>
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<tr>
<td>Shutoff head (Feet)</td>
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</tr>
<tr>
<td>Motor Horsepower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
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<tr>
<td>Impeller Size (In.)</td>
<td></td>
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</tr>
</tbody>
</table>

C. Manufacturer shall confirm that the NPSHR will be less than NPSHA at any point on the pump curve.

D. Secondary conditions will vary, based on manufacturers’ standard performance curves.

E. Pump seals shall be cool without an external coolant source.
2.3 Pump Construction

A. Major pump components shall be of gray cast iron, ASTM A48, Class 30, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of epoxy primer with an epoxy paint finish. The exterior coating of the pump as specified in Section 09900.

2.4 Motors

A. Furnish vertical, base mounted, electric, solid shaft motors compatible with the driven units.

B. Motor shall be furnished with nameplate indicating voltage, phase, current, design type; service factor; insulation class; rotation; speed; current, power factor, and start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to synchronous speed.

C. Motors shall be NEMA Design B, Class F insulation, TEFC, squirrel cage motors. Motors shall comply with IEEE and NEC and be non-overloading at any point on the pump curve.

D. Motors shall be suitable for operation with controllers as indicated on the Contract Drawings. Motors for Variable Frequency Drive applications shall be rated for inverter duty and shall have insulated ODE bearings and a shaft grounding strap. Bearing probes shall be insulated to prevent shorting out bearing insulation.

E. Motors shall be independently mounted and supported by high ring base support stands with adequately sized openings providing easy access to the coupling flange.

F. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 at an operating temperature of 104 degrees F ambient and with a temperature rise not to exceed 190 degrees F. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

G. The motor horsepower shall be adequate so that the pump is non-overloading throughout the pump’s entire performance curve.

2.5 High Ring Bases

A. Motors for sewage pumps shall be mounted on cast iron barrel type high ring bases of sufficient strength to support the full weight of the motor and of adequate height to permit access to the shaft coupling. The bases shall be furnished with a shaft guard.

2.6 Drive Shaft and Bearings

A. The connecting shafts shall have universal couplings and solid pillow block
intermediate bearings located at the shaft steady beams. The shafts shall run in ball bearings and shall be designed to withstand all radial and thrust loads applied throughout the normal pump operating range.

B. The intermediate pillow block bearings shall be designed in accordance with AFBMA standards for a minimum L-10 life of 50,000 hours. The bearings shall be sealed and contained in dust-proof moisture-proof housing. The deflection of both joints for intermediate shafts shall be equal to one another within plus or minus one degree.

C. Maximum joint operating angle shall not exceed $\frac{1}{2}$ to one degree maximum offset, unless otherwise recommended by the pump manufacturer. Shaft deflection at the pump shall not exceed 0.002-inch at the stuffing box at plus/minus 40% of the best efficiency point of the impeller curve furnished.

D. Bearings shall be grease lubricated through fittings provided at accessible points on the bearing housing and metal tubing and fittings shall be provided to allow bearing lubrication from floor level. Tubing shall be securely fastened to steady beams and wall. Shaft guards shall be provided.

2.7 Pump Shaft Assemblies

A. Pump shafts shall be high-strength alloy steel with a minimum 100,000 psi tensile strength and 75,000 psi yield strength, shafts shall be of sufficient diameter to carry the maximum loads imposed and to prevent vibration and fatigue.

B. Shafts shall be accurately machined along their entire length and precision ground at bearing locations. Keyways shall be provided at both ends.

C. A renewable shaft sleeve with positive O-ring sealed to prevent leakage between the shaft and the sleeve shall protect the shaft through the sealing box area.

D. The shaft sleeve shall be stainless steel with a Brinell hardness of 425-475 (on mechanical seal pumps, shaft sleeves may be corrosion-resistant bronze).

E. Radial bearings shall be grease-lubricated ball bearings designed to carry the hydraulic radial loads encountered in the service conditions. Thrust (outboard) bearings shall be designed to carry the pump hydraulic axial and dead load thrust. Bearing shall be designed for an L-10 life of 50,000 hours per ABMA at any operating point on the pump performance curve.

2.8 Impeller

A. Impellers shall be non-clog type, manufactured of close-grained cast iron conforming to ASTM A48, Class 30.

B. Impellers shall be of one piece, single suction, enclosed radial flow design with well-rounded leading vane edges and a thick hydrofoil shape with large openings to prevent the accumulation of solids and stringy material.

C. The clearance between the impeller outside diameter and cutwater shall be capable of
passing a 3-inch sphere. Impellers shall be statically and dynamically balanced and secured to a straight or tapered fit on the pump shaft by means of a bolt, washer and key. The arrangement shall be such that the impeller cannot be loosened by operating torque in either forward or reverse rotation.

2.9 Volute

A. Volutes shall be made of close-grained cast iron conforming to ASTM A48, Class 30 and of one-piece design with smooth fluid passages large enough to pass any size solid that can pass through the impeller.

B. Volutes shall be side flanged tangential discharge and capable of rotation in 45-degree increments to accommodate piping orientation. Diffusion vanes are not permitted.

C. Volute discharge shall be a minimum of 4” diameter.

D. Volutes shall be furnished with large cleanout openings located at the impeller centerline, to allow access to the impeller.

E. Volute shall be furnished with a ¼ inch diameter tap for an air vent and a ½ inch diameter tap for a gauge connection. Both taps shall be located on top of the volute.

F. Flanges shall be ASME/ANSI B16.1 class 125 raised or flat faced flanges. Casings shall be designed to permit the removal of the rotating assembly without disturbing the suction or discharge piping.

G. Casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head, whichever is greater.

2.10 Front-Heads and Back-Heads

A. Front-heads shall be of close-grained cast iron conforming to ASTM A48, Class 30 and shall be cast separately and connected to the suction elbow.

B. A separately cast, close-grained cast iron, back-head with large access openings and integral sealing box conforming to ASTM A48 Class 30 shall be provided.

C. Sealing boxes shall be designed for use with conventional packing. The sealing box shall be furnished with a 1/4-inch injection and vent tap for a clear water or grease connection to a water seal ring to prevent air from entering the pump through the sealing box. A ¾-inch minimum back-head drain tap shall be provided. Sealing box leakage shall be collected by the back-head drain trough and piped directly to drain, eliminating any drippage onto the floor.

D. A minimum of 5 rings of graphite-impregnated synthetic packing and a split Teflon water seal ring shall be furnished. Glands shall be two-piece, split, interlocking, made of cast iron. They shall be held in place by studs and nuts.
2.11 Wear Rings
   A. Pumps shall be equipped with replaceable stationary and mobile wear rings.
   B. The stationary wear ring shall be stainless steel with a Brinell hardness of 425-475.
   C. The mobile wear ring shall be stainless steel with a Brinell hardness of 325-350.

2.12 Bases
   A. Rugged heavy duty fabricated steel bases shall be provided, with openings large enough to permit access to the suction elbow and cleanout, bolted directly to the volute. Bases shall be designed to support the assembled weight of the pump and driver shafting.
   B. A cast iron suction elbow with contoured handhold cleanout, and ANSI B16.1 class 125 raised or flat faced flanges shall be furnished.

2.13 Spare Parts
   A. One full diameter spare impeller, shaft sleeve, and impeller fastening hardware, one set of rings; and one spare set of packing shall be provided with each sewage pump furnished.

2.14 Sump Pump
   A. The sump pump shall be a submersible unit capable of pumping 20 gpm at 20 feet of head. The unit shall have a 115/230-volt single-phase 1/2 HP (min.) motor. The unit shall be equipped with a vertical slide float. The unit shall be equipped with a 1-1/2-inch NPT discharge. The unit shall be hard wired to the L.P. panel on a dedicated circuit. No other components will be permitted on the sump pump circuit. If a junction box is required between the pump and the panel, the junction box shall be waterproof.

3. Execution

3.1 Installation
   A. Pumping equipment shall be installed in accordance with recommendations of the manufacturer, and the details shown on the Contract Drawings. A copy of the installation instructions shall be made available to the ENGINEER and the OWNER prior to equipment installation.
   B. The CONTRACTOR shall dynamically balance and align the shaft assembly, in the field, to within the pump manufacturer’s required tolerance.
   C. In the event any equipment fails to meet the specifications, it shall be modified and retested in accordance with these specifications.
3.2 Pump Testing

A. After installation, the pumping system shall be field tested using potable water. The CONTRACTOR shall be responsible for providing water and for conveying the water to the site and providing required meter and back-flow prevention check valve assembly. Each pump shall be cycled through the sequence of operation “pump on” as the level rises in the wet well and then “pump off” during draw down. Once each pump has been tested separately, the pumps will be operated in parallel.

B. Each pump shall operate over its intended operating range without undue noise, vibration, or cavitation. The CONTRACTOR shall monitor and record vibration at three symmetrically located points on each pump at maximum and minimum speed and supply data to the OWNER. Each pump shall operate within the tolerances established in the Hydraulics Institute (HI) standards and within an acceptable range on the certified pump curve provided by the manufacturer.

C. Upon completion of the installation, on-site testing, and before acceptance by the OWNER, the Pump Manufacturer or the authorized Pump Manufacturer’s Representative shall submit a written statement that the pump installation has been completed in accordance with the manufacturer’s recommendations.

3.3 Manufacturer’s Representative

A. Provide manufacturer’s representative in accordance with Section 01650 – Starting of System.

B. Prior to Operational Testing, the CONTRACTOR shall have the manufacturer do the following:

1) Megger test the stator and power cables.

2) Check proper rotation.

3) Check power supply voltage.

4) Measure motor operating load and no load current.

5) Check level control operation and sequence.

C. During this Final Acceptance Testing, the manufacturer's service representative shall review recommended operation and maintenance procedures with the OWNER'S personnel.

END OF SECTION
Section 15150 – Non-Clog Submersible Centrifugal Pumps and Drives

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing wet-pit and dry-pit non-clog, submersible centrifugal pumps and drives.

B. Related Sections

01000 Special Provisions
01600 Materials and Equipment
01650 Starting of System
09900 Painting
13329 Sequence of Operation
15163 Variable Frequency Drives
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16260 Motor Controllers
16310 Motor Control Panel

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Certified performance curves in accordance with Hydraulic Institute Standards signed and sealed by the manufacturer’s licensed professional engineer.

2) Certified copies of results of hydrostatic test.

3) Setting plans which shall include:

   (a) Anchor bolt layout and bolt dimensions.

   (b) Outline dimensions and weights of pumps and guiderail system.

4) Pumps: Submittal data and drawings shall include:

   (a) Manufacturer, type, and model number.

   (b) Assembly drawing, nomenclature and material list, O&M manual, and parts list.

   (c) Impeller type, diameter, sphere size passing, number of vanes and identification number.

   (d) Complete motor performance data including: HP rating, full load current, efficiency; voltage/phase/ frequency;
(e) Complete performance curve(s) showing full range (shutoff to run-out) head vs. capacity, NPSHR, hydraulic efficiency, motor active (KW) input power, and shaft power (BHP).

(f) The manufacturer shall indicate, by arrows to points on the flow versus head in feet of water curves, the limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation and vibration. The stable operating range shall meet the hydraulic performance requirements of the proposed system.

(g) A copy of the system head curves and recommend pump performance curves are included in Section 01000 - Special Provisions. The system head curves include high and low head conditions with appropriate friction factors. The system head curves shall be plotted on the CONTRACTOR’S proposed pump curve and submitted for review.

5) Location and description of Service Centers and spare parts stock.

6) Bearing life projection and warranty at the specified operating condition.

7) Operations and Maintenance Manual in accordance with Section 01600.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. Hydraulic Institute Standards (HI)

C. American Society for Testing Materials (ASTM)
   2) ASTM A470 Standard Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts

D. American Iron and Steel Institute (AISI)

E. Insulated Cable Engineers Association (ICEA)

F. American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI)
   1) B16.1 Gray Iron Pipe Flanges and Flanged Fittings

G. National Electrical Manufacturers Association (NEMA)

H. Institute of Electrical and Electronics Engineers (IEEE)
I. National Electric Code (NEC)

J. American Bearing Manufacturers Association (ABMA)

2. Products

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Pump Performance

A. The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40 degrees to 104 degrees F.

B. Sewage pumps shall be submersible centrifugal sewage pumps as shown on drawings with operating parameters as follows (see section 01000 - Special Provisions for details):

<table>
<thead>
<tr>
<th></th>
<th>Primary Condition</th>
<th>Secondary Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (gpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Dynamic Head (Feet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Horsepower at Design Condition (bhp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed at Design Condition (rpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shutoff head (Feet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Horsepower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impeller Size (In.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Manufacturer shall confirm that NPSHR will be less than NPSHA at any point on the pump curve.

D. Secondary conditions will vary, based on manufacturers standard performance curves.

E. Pump seals shall be cooled without an external coolant source.
2.3 Pump Construction

A. Major pump components shall be of gray cast iron, ASTM A48, Class 30, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of epoxy primer with an epoxy paint finish. The exterior coating of the pump as specified in Section 09900.

B. Sealing design shall incorporate metal to metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes, and O-ring contact of four sides without the requirement of a specific bolt torque limit.

2.4 Cooling System

A. Wet-pit: Motors shall be externally cooled by submergence in the pumped media.

B. Dry-Pit: Motors shall be internally cooled by the pumped liquid and externally cooled by surrounding atmosphere. Closed cooling systems utilizing secondary cooling liquids such as potable water or glycol shall not be used.

2.5 Cables

A. The cable entry seal design shall insure a watertight and submersible seal. Each motor shall be fitted with sufficient cable so that no splices are required between the pump and the pump starters. The CONTRACTOR shall supply two separate cables for each pump and coordinate the required cable length for the installation as shown on the drawing. Control wiring or sensor cables shall be run in separate conduit than power cable or wiring. Cable restraints and supports shall be suitable to support cable without damage to the cable and be 316 stainless steel.

B. The power cable shall be Type ATC, SOW, or W and sized according to the NEC and ICEA standards and shall be of sufficient length to reach the control panel without the need of any splices. The outer jacket of the cable shall be oil resistant rubber.

2.6 Motors

A. Motor shall be furnished with nameplate indicating voltage, phase, current, design type; service factor; insulation class; rotation; speed; current, power factor, and start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to synchronous speed.

B. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air or oil filled, watertight chamber, NEMA B type. Motor shall be UL listed for use in Class I, Division 1, Group C and D hazardous locations. The stator windings and stator leads shall be insulated with moisture resistant Class F installation rated for 311 degrees F. The stator shall be dipped and baked three times
in Class F varnish, and shall be heat-shrink fitted into the stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable.

C. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 104 degrees F and capable of up to 10 evenly spaced starts per hour. The motor and cable shall be capable of continuous submersion underwater to a depth of 65 feet without loss of watertight integrity.

D. Thermal switches shall be imbedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be set to open at 125 degrees C, and shall be used in conjunction with and supplemental to external motor overload protection; and shall be connected to the control panel.

E. Dual moisture detection probes shall detect the entrance of moisture and provide an alarm. The moisture detection probes shall detect the entrance of moisture in the stator and lower seal cavity and send an alarm to the control panel. Single probe or float switch sensors shall not be allowed.

F. Motors shall be suitable for operation with controllers as indicated on the Contract Drawings. Motors for Variable Frequency Drive applications shall be rated for induction inverter duty.

G. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 at an operating temperature of 104 degrees F ambient and with a temperature rise not to exceed 190 degrees F. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

H. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve.

2.7 Bearings

A. The pump shaft shall rotate on bearings with a minimum L10 bearing life of 50,000 hours at any point along the usable portion of the pump curve.

B. For Inverter Duty Motors

1) Insulate the ODE bearing and provide a shaft grounding strap. Insulate bearing probes to prevent shorting out bearing insulation.

2.8 Mechanical Seal

A. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in an oil reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating tungsten carbide or silicon carbide ring. The upper,
secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary tungsten carbide seal ring and one positively driven rotating silicon carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction rotation without damage or loss of seal. For special applications, other seal face materials shall be available.

B. Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be design to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug, with position anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication.

2.9 Pump Shaft

A. Pump and motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of AISI Type 416 stainless steel, and shall be completely isolated from the pumped liquid.

2.10 Impeller

A. Impellers shall be non-clog type, manufactured of close-grained cast iron conforming to ASTM A48, Class 30.

B. Impellers shall be of one piece, single suction, enclosed radial flow design with well-rounded leading vane edges and a thick hydrofoil shape with large openings to prevent the accumulation of solids and stringy material.

C. The clearance between the impeller outside diameter and cutwater shall be capable of passing a 3-inch sphere. Impellers shall be statically and dynamically balanced and secured to a straight or tapered fit on the pump shaft by means of a bolt, washer and key. The arrangement shall be such that the impeller cannot be loosened by operating torque in either forward or reverse rotation.

2.11 Volute

A. Volutes shall be made of close-grained cast iron conforming to ASTM A48, Class 30 and of one piece design with smooth fluid passages large enough to pass any size solid that can pass through the impeller.

B. Volutes shall be flanged with discharge as shown on the Contract Drawings. Diffusion vanes are not permitted.

C. Volute discharge shall be a minimum of 4" diameter.

D. Volutes shall be furnished with large cleanout openings located at the impeller centerline, to allow access to the impeller.

E. Flanges shall be ASME/ANSI B16.1 class 125 raised or flat faced flanges.
F. Casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff head, whichever is greater.

G. Dry pit pump volute shall be furnished with a ¾ inch diameter tap for an air vent and a ½ inch diameter tap for a gauge connection. Both taps shall be located on top of the volute.

2.12 Wear Rings

A. Pumps shall be equipped with replaceable stationary and mobile wear rings.

B. The stationary wear ring shall be stainless steel with a Brinell hardness of 425-475.

C. The mobile wear ring shall be stainless steel with a Brinell hardness of 325-350.

2.13 Pump/Motor Protection Relay

A. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. Should high temperature occur, the thermal switches shall open, stop the motor and activate an alarm.

B. A leakage sensor shall be provided to detect water in the stator chamber. When activated, the leakage sensor will activate an alarm.

C. Each pump shall be provided with its own self-contained control and status module, which will be mounted within the pump control panel. This module shall provide a single point within the control system for pump sensor output processing. The module shall have a manual reset.

D. All alarms connected to the control and status module shall be integrated with the RTU/PLC panel.

2.14 Guide Rail Bracket and Discharge Base for Wet-Pit Pumps

A. The sliding bracket assembly shall be a part of the pumping unit and constructed such that, when the pumping unit is lowered onto the discharge base elbow, the knifing action of the vertical metal to metal seal will provide a self-cleaning, non-clogging, non-sparking assembly.

B. Two 316 stainless steel rails shall be provided to guide the pump when it is being raised or lowered in the wet well. They shall mount on the discharge base/elbow provided by the pump manufacturer and be secured at the top to the top slab. The rails shall guide the pump into position on the discharge elbow as it is lowered into place. The rail guide system shall be secured to the wall discharge piping with intermediate 316 stainless steel brackets at no more than 8- foot intervals.

C. The discharge base shall be rigid, set and secured to the concrete floor of the wet well and shall be capable of supporting the total weight of the pumping unit and discharge piping. The base shall be bolted directly to the wet well bottom slab using 316 SS adhesive anchors or cast in place SS anchor bolts. The discharge base shall include a
90 degree elbow with a 125 pound ANSI flange discharging vertically, be suitable for
the pump and be of manufactured of either cast or ductile iron.

D. A 316 stainless steel cable shall be provided for each pump with a suitable stainless
steel bracket at the top for holding the cable within easy reach through the hatch.

2.15 Spare Parts

A. One spare full diameter impeller and one spare set of mechanical seals.

2.16 Sump Pump

A. The sump pump shall be a submersible unit capable of pumping 20 gpm at 20 feet of
head. The unit shall have a 115/230-volt single-phase 1/2 HP (min.) motor. The unit
shall be equipped with a vertical slide float. The unit shall be equipped with a 1-1/2-
inch NPT discharge. The unit shall be hard wired to the L.P. panel on a dedicated
circuit. No other components will be permitted on the sump pump circuit. If a
junction box is required between the pump and the panel, the junction box shall be
waterproof.

3. Execution.

3.1 Installation

A. Pumping equipment shall be installed in accordance with recommendations of the
manufacturer, and the details shown on the contract drawings. A copy of the
installation instructions shall be made available to the ENGINEER and the OWNER
prior to equipment installation.

B. In the event any equipment fails to meet the specifications, it shall be modified and
retested in accordance with these specifications.

3.2 Pump Testing

A. After installation, the pumping system shall be field tested using potable water. The
CONTRACTOR shall be responsible for providing water and for conveying the
water to the site and providing required meter and back-flow prevention check valve
assembly. Each pump shall be cycled through the sequence of operation ‘pump on”
as the level rises in the wet well and then “pump off” during draw down. Once each
pump has been tested separately, the pumps will be operated in parallel.

B. Each pump shall operate over its intended operating range without undue noise,
vibration, or cavitation. The CONTRACTOR shall monitor and record vibration at
three symmetrically located points on each pump at maximum and minimum speed
and supply data to the OWNER. Each pump shall operate within the tolerances
established in the Hydraulics Institute (HI) standards and within an acceptable range
on the certified pump curve provided by the manufacturer.

C. Upon completion of the installation, on-site testing, and before acceptance by the
OWNER, the Pump Manufacturer or the authorized Pump Manufacturer’s
Representative shall submit a written statement that the pump installation has been
completed in accordance with the manufacturer’s recommendations.

3.3 Manufacturer’s Representative

A. Provide manufacturer’s representative in accordance with Section 01650 – Starting of System.

B. Prior to Operational Testing, the CONTRACTOR shall have the manufacturer do the following:

1) Megger test the stator and power cables.

2) Check proper rotation.

3) Check power supply voltage.

4) Measure motor operating load and no load current.

5) Check level control operation and sequence.

C. During Final Acceptance Testing, the manufacturer's service representative shall review recommended operation and maintenance procedures with the OWNER’S personnel.

END OF SECTION
Section 15160 – Diesel-Engine Driven Emergency Pumping System

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing the diesel-engine driven emergency self-priming pumping system to provide pumping capability in the event of power failure or station pump failure.

B. Related sections

01600 Materials and Equipment
01650 Starting of Systems
15170 Level, Pressure, and Intrusion Sensing Systems

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1) Setting plans which shall include:

(a) Anchor bolt layout.

(b) Anchor bolt dimensions.

(c) Outline dimensions and weights of pumps, fuel storage, and enclosures.

2) Pumps: Submittal data and drawings shall include:

(a) Certified performance curves signed and sealed by the manufacturer’s licensed professional engineer.

(b) Certified copies of results of hydrostatic test.

(c) Manufacturer, type, and model number.

(d) Assembly drawing, nomenclature and material list, O&M manual, and parts list.

(e) Impeller type, diameter, sphere size passing, number of vanes and identification number.

(f) Complete performance curve(s) showing full range (shutoff to run-out) head vs. capacity

(g) A copy of the system head curves and recommend pump performance curves are included in Section 01000 - Special Provisions. The system head curves include high and low head conditions with appropriate friction factors. The
system head curves shall be plotted on the CONTRACTOR’S proposed pump curve and submitted for review.

(h) The manufacturer shall indicate, by arrows to points on the flow versus head in feet of water curves; the limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation and vibration. The stable operating range shall meet the hydraulic performance requirements of the proposed system and submitted for review.

(i) Controls and accessories

3) Engine information including a certified continuous duty engine curve.

4) Fuel tank information

5) Automatic tank gauging system information

6) System enclosure information

7) Location and description of Service Centers and spare parts stock.

8) Operations and Maintenance Manual in accordance with Section 01600.

9) Warranty

(a) The manufacturer shall furnish to the OWNER a five-year Parts and Labor Warranty issued by the manufacturer on the Pumping System. This warranty shall cover the entire Diesel Engine Driven Pumping System as specified.

10) A list of five user contacts including contact names and telephone numbers shall be provided with the bid submittal.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American Society for Testing and Materials (ASTM)


2) ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

3) ASTM A36/A36M Standard Specification for Carbon Structural Steel

C. AISI B American Iron and Steel Institute

D. ANSI American National Standards Institute (ANSI)
1) ANSI B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings

E. Underwriters Laboratories

1) UL-142 – Steel Above-Ground Tanks for Flammable and Combustible Liquids

F. National Fire Protection Association

1) NFPA 30 - Flammable and Combustible Liquids Code

2) NFPS 37 - Standard for Installation and Use of Stationary Combustible Engine and Gas Turbines

3) NFPA 110 - Standard for Emergency and Standby Power Systems

2. Products

2.1 Products

A. System Description

1) Provide a new, diesel engine-driven, skid-mounted, automatically started/stopped, packaged bypass pumping system installed in weather protective, sound attenuating (critically silenced) enclosure for pumping raw sewage in the event of high water in the pump station wet well.

2) The unit shall consist of a liquid-cooled, diesel fueled engine coupled to a suction lift type sewage pump complete with control panel, auxiliaries, meters, and safety devices necessary for a complete operating system.

3) The bypass pumping unit shall be the product of a firm regularly engaged in the manufacture of such units and shall meet the requirements set forth herein. The equipment shall be a standard model in regular production at the manufacturer’s place of business. In order to be considered, a supplier must be the manufacturer of either the engine or the pump. All components shall be covered under the warrantee of the supplier.

4) Units shall be new, unused and of the current year’s production. The style of pump being provided shall be in production and shall have been in continuous use by municipal and industrial owners for a minimum of 5 years). Unit shall be of the latest design and in current production completely serviced, ready for operation and shall include all standard and optional equipment as specified herein.

5) The pump shall be fitted with a fully automatic priming system incorporating an air compressor, air ejector assembly, and an air/water separation tank. No water shall be required in the pump to achieve a prime. The air ejector shall operate on the discharge side of the compressor, eliminating the possibility of water being drawn into the air source.

6) The priming system shall not use a vacuum or diaphragm pump, nor require the
use of a foot-type valve. It shall contain no moving parts or protective float gear. Priming systems that require manual water additions to facilitate pump priming are not acceptable.

7) Equipment acceptance shall be contingent upon its ability to run in a completely dry condition for periods up to 24 continuous hours at full speed.

8) Normal adjustments and maintenance shall be easily accessible and shall not require the use of special tools.

B. The pump and accessories shall be supplied by the pump manufacturer.

C. Manufacturers must have a fully stocked parts and service facility within a 50 mile radius of the project site. The OWNER shall have the right to inspect their facilities and shall be the sole judge of its adequacy to fulfill this requirement.

2.2 Pump Performance

A. The permanent, skid-mounted pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40 degrees to 104 degrees F.

B. The pump shall be capable of static suction lifts to 28 feet, vertical, at sea level. It shall also be capable of operation using extended suction lines.

C. Pumps shall be diesel engine-driven centrifugal sewage pumps as shown on Contract Drawings with operating parameters as follows (see section 01000 - Special Provisions for details):

<table>
<thead>
<tr>
<th>Primary Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Operating Speed (gpm)</td>
</tr>
<tr>
<td>Minimum Solids Handling Size (In.)</td>
</tr>
<tr>
<td>Impeller Size (In.)</td>
</tr>
<tr>
<td>Suction Connection Size (In)</td>
</tr>
<tr>
<td>Discharge Connection Size (In)</td>
</tr>
<tr>
<td>Maximum Suction Lift (Feet)</td>
</tr>
<tr>
<td>Pump Shut-off Head (Feet)</td>
</tr>
<tr>
<td>Maximum Duty Point @ TDH in Feet</td>
</tr>
<tr>
<td>Second Duty Point @ TDH in Feet</td>
</tr>
</tbody>
</table>

D. Manufacturer shall confirm that the NPSHR will be less than NPSHA at any point on
the pump curve.

E. Secondary conditions will vary, based on manufacturers standard performance curves.

2.3 Pump Construction

A. Major pump components shall be of gray cast iron, ASTM A48, Class 30, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of epoxy primer with an epoxy paint finish.

B. Volute discharge shall be a minimum of 4" diameter.

C. Pump design shall incorporate a direct suction flow path that is in axial alignment with the impeller eye. There shall be no turns, chambers, or valves between the suction flange and the impeller eye.

D. Sealing design shall incorporate metal to metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes, and O-ring contact of four sides without the requirement of a specific bolt torque limit.

2.4 Impellers

A. The pump impeller shall be of open non-clog type with pump out vanes on the back shroud.

B. The impeller shall be Two-bladed of hardened cast chromium steel construction. Shrouded or semi-shrouded (non-clog) impellers will not be accepted.

2.5 Wear Plates

A. Wear plates shall be fully adjustable and replaceable, fabricated of cast iron. Wear plate clearances shall have no relationship to the ability of the pump to achieve a prime. The pump wear plates shall be of a diameter equal to or greater than the impeller diameter to insure maximum protection to the pump casing. Under no circumstances will wear rings be accepted.

2.6 Bearings and Shafts

A. Pump shall be fitted with a bearing bracket which contains the shaft and heavy-duty ball or tapered roller bearings of adequate size to withstand imposed loads. Minimum I.S.O. L10 bearing life to be 100,000 hours. Impeller shaft shall be of 1⅝% chromium alloy and have a minimum diameter of 60mm at the pump seal.

2.7 Mechanical Seals

A. Seals shall be high pressure, back to back double mechanical self-adjusting type with solid silicon carbide faces capable of withstanding suction pressures to 100 psi.
B. The mechanical seal shall be cooled and lubricated in an oil bath reservoir, requiring no maintenance or adjustment. All metal parts shall be of stainless steel. Elastomers shall be Viton.

2.8 Pump Flanges, Gaskets and O-rings

A. Pump suction and discharge flanges shall be cast iron ANSI (B16.1) Class 150, raised faced.

B. Pump gaskets shall be compressed fiber and/or Teflon.

C. Pump O-rings: shall be Viton.

2.9 Priming System

A. Pump shall be fitted with a fully automatic priming system incorporating a twin-cylinder compressor and air ejector assembly. No vacuum pumps will be accepted. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated and cooled from the engine. The priming system shall require no fail-safe protection float gear or any adjusting at high or low suction lifts.

2.10 Check Valve

A. Pump shall be supplied with an integral swing-type check valve mounted on the discharge flange of the pump, allowing unrestricted flow into the impeller. The check valve shall prevent in-line return of flow when the pump is shut off. Non-return valve elastomers shall be Nitrile Rubber, and shall be field replaceable.

2.11 Drive Unit

A. The drive unit shall be an interim Tier 4 diesel water-cooled engine. Engine shall drive pump by use of direct connected intermediate drive plate.

B. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure, and high temperature shall be integral to the pump control panel. A tachometer, and hour meter shall be integral to the pump control panel. Battery shall have 180 Amp hour rating.

C. Unit shall have the following emissions control equipment: Diesel Oxidation Catalyst, Diesel Particulate Filter, and NOx Reduction System.

2.12 Governor

A. Governor shall be electronic type. Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds.

2.13 Exhaust System

A. Exhaust system shall include a hospital grade muffler housed in a separate chamber within the enclosure. All exhaust piping and manifolds shall be encased in fitted
acoustic blankets. They shall be constructed of high-density fiberglass material with waterproof jacketing.

2.14 Sound Attenuation Enclosure

A. The engine and pump shall be completely enclosed with 14-gauge sheet metal panels backed with one inch and two-inch layers of polydamp acoustical sound-deadening material creating a weather proof sound attenuating enclosure.

B. The acoustical enclosure shall reduce pump and engine noise to sixty-eight dBA or less at a distance of thirty feet. The enclosure shall be removable for easy access to the engine / pump for maintenance and repair.

C. The enclosure doors shall all be equipped with latches that are keyed alike. For maintenance and service needs, the enclosure sides shall have hinged doors for quick access to the engine oil fill, fuel fill port, oil dipstick, and filters.

D. All openings in the engine mounting skid and all air flow inlets and outlets in the enclosure shall be provided with rodent protection screens. Rodent protection screens shall consist of a punched metal panel with square openings sized to permit air flow required by the engine manufacturer. The punched metal panel openings shall be covered with aluminum or stainless steel insect/rodent screen to prevent pests from entering the mounting skid and enclosure.

2.15 UL Listed Skid Base Fuel Tank

A. The pump base tank shall be a UL-142 approved double wall design constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; The Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and The Standard for Emergency and Standby Power Systems, NFPA 110.

B. The tank design shall be a Closed Top Dike Pump Base Tank. It shall be of double wall construction having a primary tank to contain the diesel fuel, held within another tank or dike, which is intended to collect and contain any accidental leakage from the primary fuel tank. The completed base tank assembly is to incorporate pump mounting locations and must be able to support four times the rated load. – Tank shall be sized to accommodate a minimum of 24 hours of operation under full load.

C. The primary tank shall be designed to withstand normal and emergency internal pressures and external loads. It shall be capable of withstanding internal air pressures of 3 to 5 psig without showing signs of excessive or permanent distortion and 25 psig hydrostatic pressure without evidence of rupture or leakage.

D. The primary and secondary tanks or dike shall have venting provisions to prevent the development of vacuum or pressure capable of distorting them as a result of the atmospheric temperature changes or while emptying or filling. The vent shall also permit the relief of internal pressures caused by exposure to fires. The vent size shall be determined by using the calculated wetted surface area in square feet (the top is excluded) in conjunction with venting capacity table 10.1of UL-142. The tank’s vent shall also be equipped with a coupling device and shall be located to facilitate connection to a vent piping system. The dike’s vent may be an opening for venting
directly to the atmosphere and protection from the entrance of natural elements or debris shall be provided.

E. The primary tank shall be constructed of 7 gauge ASTM A1011/A1011M or A36/A36M hot rolled steel. Internal baffles or reinforcement plates shall be located on a maximum of 24 inch centers in tanks up to 60 inch width and on a maximum of 19.5 inch centers in tanks over 60 inch width. At least one baffle shall separate the fuel suction pipe from the fuel return line.

F. The outer tank shall be designed and constructed to support four times the wet load of the pump and housing. All of the load shall be carried by the outer tank so that no load or vibration stress is placed on the primary tank. If the pump base tank is wider than the pump set to be supported, structural rails shall be incorporated to span the width of the base tank so that the load is transferred to the side rails of the tank. Vertical reinforcements shall be welded to the outer sides of the secondary tank or dike at a maximum of 45 inch centers on tanks up to 30 inches high and on 24 inch centers on tanks greater than 30 inches high. At least one vertical reinforcement shall be positioned adjacent to each mounting hole location.

G. Both primary and secondary tanks shall be fitted with the properly welded pipe fittings to accommodate the requirements for the fill port and normal and emergency venting.

H. Prior to painting the completed assembly shall be cleaned with a heated pressure wash followed by a chromium free post treatment to ensure proper paint adhesion. The tank assembly shall be painted with an epoxy ester primer and high quality polyurethane enamel with total paint thickness of 3.5 mils. The painted tank assembly shall be baked at 180 degrees for 30 minutes to provide a hard durable finish.

I. A UL label shall be permanently attached to the tank system showing the following information:

1) The registered UL mark and the name: Underwriters Laboratories, Inc.
2) A control number and the word “listed”
3) The product’s name as identified by Underwriters Laboratories Inc.
4) The serial number assigned by Underwriters Laboratories, Inc.
5) Other manufacturer’s information may also be included.

2.16 Factory Painting

A. Pump, engine, base, shall be shop primed and finish painted at the place of manufacture. Materials and thickness for priming shall be in accordance with manufacturer's standards.

2.17 Pump Control Integration

A. The engine shall start/stop from the signal supplied by the 4-20 mA signal provided by the submersible level transducer provided under Section 15170. This transducer is in a
stilling well located in the pump station wet well and provided under Section 15170.

B. Upon loss of signal from the submersible level transducer, the engine start command will be initiated by a separate float switch (provided under this Section, but material specifications shall be in accordance with Section 15170). In addition to the start command, the float switch shall indicate wet well high level and alarm. High level indication shall alarm both locally on the engine control panel and remotely through SCADA.

C. Engine stop command shall be initiated by the wet well high-level float switch provided under Section 15170.

D. The pump controls panel shall have dry running status contacts that will be used to interlock with pump starting equipment to prevent the electrically driven pumps from operating simultaneously with the diesel driven pump.

2.18 Automatic Engine Starting Control System

A. The engine shall be equipped with a factory installed microprocessor-based controller as supplied by diesel engine-driven pumping system manufacturer and designed to start/stop the engine.

B. The controller shall be in a weather proof enclosure and contain an external weatherproof 12-position keypad accessible without removing or opening any protective cover or enclosure.

C. Engine / Pump Control Specifications

1) The engine shall be started, stopped, and controlled by a digital controller as supplied by the diesel engine-driven pumping system manufacturer. The controller shall be weather-proof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. The control system shall provide the following functions without modification, factory recalibration or change of chips or boards by simply accessing the keypad.

(a) The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, with gloves, through ice, snow, mud, grease, etc. and maintain complete weather tight sealing of the control panel.

(b) In automatic mode, the unit shall conserve energy and go to “sleep”.

(c) The panel shall function interchangeably from transducer signal as well as by manual start/stop by selection at the keypad. No other equipment or hardware changes shall be required.

(d) The panel shall be capable of varying the engine speed via the keypad.

(e) The start function shall be programmable to provide 3 separate functions each day for 7 days (i.e. a start, warm up, exercise cycle on two separate days
at different times and for a varying length of time all via the keypad).

(f) Manual-Automatic Button:

1. In Manual Mode, Manual “Start” button starts engine and runs until “Stop” button is depressed or an emergency shutdown occurs.

2. In Automatic Mode start/stop sequencing is initiated by a submersible level transducer. Engine speed shall be varied based on discharge pressure.

D. The controller shall integrate the engine safety shut-off for low-oil pressure, high-temperature, and provide over-speed protection.

E. The controller shall include standard field adjustable parameters for engine cycle crank timer, shutdown time delay, warm-up time delay, and cool-down time delay.

F. The Panel shall have only one circuit board with 8 built in relays. Each relay shall be named to provide any function via the key pad without changing relays, chips, printed circuits or any hardware or software.

G. Standard components shall consist of 24 digital inputs, seven analog inputs, one magnetic pick-up input, eight 20-amp form “C” relays, one RS232 port, one RS485 port, one RS232/RS485 port, one J1939 port, and one 64X128 pixel full graphic LCD display with backlight.

H. The industrially hardened panel shall withstand Vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature Range of 4°C to 176°F (-20°C to 80°C) and an operating humidity range of 0-95% Non-Condensing.

I. Electrical Junction Box

1) The unit shall include a duplex GFCI outlet (junction box) for a single point electrical connection circuit to power the engine coolant heater sized based on the circuit requirements for the heater.

J. Fully Automatic Trickle Charger

1) The unit shall include a fully automatic trickle charger powered by 6-amps, 115 VAC.

K. Engine Block / Coolant Heater

1) The drive unit shall be supplier with an integral thermostatically controlled engine block heater (20-amp, 115 VAC required).

L. DC/AC Inverter:

1) The unit shall include one 12 VDC to 120 VAC single phase inverter, 1750 watts, terminate 120 VAC source at one (1) 15A-1P circuit breaker mounted inside enclosure for connection to the station PLC battery charger
M. Light

1) The unit shall include a single switch operated 12 VDC light within the enclosure.

N. Automatic Tank Gauging System

1) The automatic tank gauging system shall provide continuous monitoring of the amount of fuel in the tank, provide statistical and static leak detection, include ethernet and IP communications. The system shall be configurable to sense up to 64 sensors, allow external inputs and relay outputs, record engine run activity, and provide compete inventory reports after engine operation.

3. Execution.

3.1 Installation

A. Pumping system shall be installed in accordance with recommendations of the manufacturer, and the details shown on the Contract Drawings. A copy of the installation instructions shall be provided to the ENGINEER and the OWNER prior to equipment installation.

B. Bypass pump unit shall be mounted on a concrete pad that is independent of all other concrete slabs or structures. Refer to the Contract Drawings for additional details.

C. In the event that any equipment fails to meet the specifications, it shall be modified and retested in accordance with these specifications.

3.2 Pump Testing

A. After installation, the pumping system shall be field tested using potable water or wastewater as approved by OWNER. The CONTRACTOR shall be responsible for conveying the water to the site and providing required meter and back-flow prevention check valve assembly. Each pump shall be cycled through the sequence of operation “pump on” as the level rises in the wet well and then “pump off” during draw down.

B. The pump shall operate over its intended operating range without undue noise, vibration, or cavitation. The CONTRACTOR shall monitor and record vibration at three symmetrically located points on the pump at maximum and minimum speed and supply data to the OWNER.

C. Upon completion of the installation, on-site testing, and before acceptance by the OWNER, the Pumping System Manufacturer or the authorized Pump System Manufacturer’s Representative shall submit a written statement that the pump installation has been completed in accordance with the manufacturer’s recommendations.

D. A demonstration of the pump’s ability to repeatedly cycle from dry suction / pump / snore / repriming / pump shall be required. This will necessitate the draining of all residual water from the pump case and suction piping to initiate a dry suction starting condition.
3.3 Manufacturer’s Representative

A. Provide manufacturer’s representative in accordance with Section 01650.

B. During Final Acceptance Testing, the manufacturer's service representative shall review recommended operation and maintenance procedures with the OWNER'S personnel. Prior to Final Acceptance testing the pump manufacturer shall submit a written report that the pump(s) are satisfactorily installed in accordance with the manufacturer’s recommendations.

3.4 Screening

A. Provide visual screening for the diesel-engine driven emergency pumping system as indicated on the Contract Drawings. Screening shall consist of a shadow box style fence with minimum 6” wide slats, minimum 50% overlap and maximum 50% gap. Minimum fence height shall match the height of the diesel-engine emergency driven pumping system enclosure. Provide dry lumber with 19% maximum moisture content at time of dressing.

3.5 Tools and Spare Parts

A. The manufacturer shall furnish a recommended list of spare parts with the diesel-engine driven emergency pumping system.

END OF SECTION
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing, and for the functionality of the equipment that reacts to the varying liquid level in the wet well or discharge pressure and varies the rotating speed of the sewage pumps in response to the level and pressure sensing system.

B. **Related Sections**

01600 Materials and Equipment
01650 Starting of System
13329 Sequence of Operation
15100 Vertical Extended Shaft Centrifugal Pumping Equipment
15150 Non-Clog Submersible Centrifugal Pumps and Drives
15170 Level, Pressure, and Intrusion Sensing Systems
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16260 Motor Controllers
16310 Motor Control Panel

1.2 **Submittals**

A. Submit shop drawings and manufacturers data in accordance with the provisions of Section I, General Provisions, and Section 01600 – Materials and Equipment.

B. Operations and Maintenance Manual in accordance with Section 01600.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1) IEEE 519 – IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

C. Association Connecting Electronic Industries (IPC)

1) IPC-CC-830B – Qualification and Performance of Electrical Insulating Compound for Printed Wiring Assemblies

1.3 **System Description**

A. VFDs shall be integrated into the motor and control systems as specified below.
B. The VFDs shall start, stop, and vary the speed of the pumps in response to changes in wet well level as sensed by level sensing system or to changes in discharge pressure as sensed by the pressure sensing system. Operation of the VFDs shall be as outlined in the Section 13329.

C. The VFDs shall be capable of automatic and manual operation. Automatic speed setting shall be from a proportional 4-20mA signal, manual control shall be accomplished using a Human Interface Module (HIM) installed on the exterior of the panel or enclosure.

D. The VFDs shall be capable of remote operation of all functions via terminal input points. All normal operating functions, e.g., starting, stopping, manual/automatic selection, speed control, and fault reset, shall be accessible from the control panel door mounted operator interface controls and/or the automatic pressure controls via the terminal input points and shall not require physical access to the VFD itself.

E. Furnish each pump motor with the quantity of VFD units as required on the Contract Drawing.

1) When one VFD per pump motor is indicated each VFD shall include a bypass controller. Provide a magnetic contactor connected to isolate the VFD when the bypass controller is in use. Selection of bypass operation shall be manual by switch on the face of the control panel or enclosure. When bypass is selected, the pump shall operate via the bypass controller regardless if the selector switch is set to hand/auto at the control panel or enclosure.

2) When two VFDs per pump motor are indicated each VFD shall be the same make and model, with the same functionality and sequence of operation. Each pair of VFDs per pump motor shall be provided with a separate VFD Alternator Cabinet as described in paragraph 2.10.

F. If the power system will be provided with a backup engine-generator set with an automatic transfer switch and a solid-state electronic voltage regulating system. Then a variable speed controller shall be provided with a line reactor, isolating transformer, filter coils or other devices on its line side, to protect the generator voltage regulating circuitry from the possible adverse effects of harmonic voltages generated in the variable speed controller.

G. Compliance Warranty: For each product, component and system, which requires computer controlled facility components, provide a statement of compliance warranty for the specific equipment. The CONTRACTOR shall warrant that each hardware, software, and firmware product delivered under this contract shall be able to accurately process date and time data (including, but not limited to, calculating, comparing, and sequencing) leap year calculations to the extent that other computer controlled components, used in combination with the computer controlled component being furnished, properly exchange date and time data with it.

H. Product Warranty: Each product, component, and system related to the VFD shall be covered by a five-year warranty. The warranty shall cover all parts and labor, and shall not be prorated.
2. **Products.**

2.1 **Products**

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 **Drive Construction and Capacities**

A. **Description:** Provide enclosed variable frequency controllers suitable for operating the indicated loads.

B. VFD Cabinets shall be labeled to meet UL-508A, shall be listed as a complete assembly, and shall have a Manufacturer’s label indicating short circuit current rating.

C. **Ratings:**

1) Rated Input Voltage: VFD shall be rated for voltage and phase as indicated on the Contract Drawings, 60 Hz. And be able to operate with plus 10% and minus 15% of rated voltage.

2) Motor Nameplate Voltage: voltage and phase as indicated on the Contract Drawings, 60 Hz.

3) Displacement Power Factor: Between 1.0 and 0.95 lagging, over entire range of operating speed and load.

4) Minimum Efficiency at Full Load: 96 percent with 4 KHz carrier.

D. **Design:**

1) Microprocessor-based inverter logic isolated from power circuits.

2) Pulse width modulated inverter system.

3) Insulated gate bipolar transistors in the inverter system operating off DC link.

4) The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. VFD’s without a DC link reactor shall provide a 5% impedance line side reactor.

5) Diode bridge rectification.

6) Design for ability to operate controller with motor disconnected from output.

7) Design to attempt automatic restart (after a loss and restoration of adequate supply power) with a 0-60 second adjustable time period between restarts. Include inhibiting feature to allow restart feature to be disabled.
E. HIM/Display Unit:

1) Description: LCD with integral keypad and user prompt menu system. Minimum of two 20-character lines

2) Functions:

(a) Display of electrical and operational values.

(b) Display of controller parameters, including configuration of three SPDT output contacts and one 4-20 mAdc analog output

(c) VFD HIM shall offer an INFO key that, when pressed, shall offer the contents of the programming manual for the feature that is currently in the display. The contents shall explain the feature and how the settings can be made.

(d) Two lines of the display shall allow “free text programming” so that a description, or the actual name, of the equipment being controlled by the VFD can be entered into the display.

(e) All VFD’s shall be of the same series and shall utilize a common control card and HIM/display unit throughout the rating range. The control cards and HIM shall be interchangeable through the entire range of drives used on the project.

F. Adjustable Controller Parameters:

1) Speed reference signal frequency. Range: 0-60 Hz.

2) Acceleration time. Range: 0-300 seconds.

3) Deceleration time. Range: 0-300 seconds.

4) Number of automatic restart attempts. Range: 0-3 attempts.

5) Time delay between restart attempts. Range: 0-180 seconds.

6) The VFD shall have four programmable “skip frequencies” with adjustable bandwidths to prevent the driven equipment from running at a mechanically resonant frequency.

G. Monitoring and Diagnostic Information:

1) Electrical and Operational Values: Display percent speed, output frequency, motor current, elapsed run time, and output voltage.

2) Diagnostic Information: Indicate under-voltage, overvoltage, motor overload, motor winding overheat and motor short circuit.

3) Fault History: Store last three faults in non-volatile memory.
H. VFD Control Inputs:

1) Dry contact input for remote start/stop
2) Isolated 4-20 mAdc analog input for remote speed reference.
3) HIM

I. Monitoring Outputs:

1) Provide normally open dry contact for remote monitoring of motor running.
2) Provide SPDT contact for remote monitoring of controller failure.
3) Provide isolated 4-20 mAdc analog output for remote monitoring of motor speed.
4) An Automatic Motor Adaptation (AMA) function shall measure motor stator resistance and reactance to optimize performance and efficiency.

J. Motor and Controller Protection:

1) Provide over-current and short circuit protection of motors on load side of isolation contactors.
2) Provide automatic shutdown of controller on under-voltage and overvoltage condition of +/- 10 percent of rated line voltage.
3) Provide three-phase motor overload protection by either internal parameter setting or separate overload block. Limit average motor current to 115 percent of motor nameplate rating. VFD shall include current sensors on all three output phases to detect and report phase loss to the motor.
4) Provide dry contact input for motor winding overheat temperature switch. Shut down controller on a motor overheat condition.
5) The VFD shall utilize voltage vector control to provide rated RMS fundamental voltage from the VFD.
6) Motor leads shall not be longer than 50 feet.

K. Line Reactor: Provide 3 percent line reactor integral to controller package to reduce surge currents, power line disturbances, and eliminate nuisance tripping of controller. The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating. VFD shall have input surge protection utilizing MOV’s, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.

L. Disconnect: Provide integral, flange-mounted, non-fusible disconnect switch on the line side of each controller.
M. Enclosure Cooling Fans: Provide control wiring to turn off cooling fans when drive unit is not operating.

N. Wiring Terminations: Match conductor materials and sizes indicated. Provide terminal strip for all discrete and analog inputs and outputs.

O. Enclosure: NEMA Type 12 enclosure with filtered ventilation. Include line reactor in controller enclosure.

P. Finish: Manufacturer’s standard enamel.

2.3 Environmental Conditions

A. The VFDs shall be capable of operation under any combination of the following conditions without mechanical or electrical damage:

   Ambient Temperature: -10 to 40 C (14 to 104 F).

   Relative Humidity: Less than 90% non-condensing.

   Vibration: Acceleration <0.5G @ 20-50 Hz Amplitude <0.1 mm @ 50-100 Hz.

   Altitude: To 3300 feet without de-rating.

2.4 VFD Controls

A. Control System, shall be Voltage Source Sinusoidal Pulse Width Modulated Waveform.

B. Volts/Hertz Ratio, second order nonlinearity mode. V/Hz automatically determined and set by the VFD microprocessor for maximum energy savings with variable torque load. The VFD will be capable of running either variable or constant torque loads. An Automatic Energy Optimization (AEO) selection feature shall be provided in the VFD to minimize energy consumption in variable torque applications. Feature shall optimize motor magnetization voltage. This feature shall dynamically adjust output voltage in response to load, independent of speed. Output voltage adjustment based on frequency alone is not acceptable for single motor VT configurations. For multi-motor variable torque configurations, user-selectable load profile curves including VT-High, VT-Medium, and VT-Low shall be provided to ensure easy commissioning and improved energy efficiency. VFD’s requiring the operator to assign load torque data-points to create a V/Hz profile, are not acceptable.

C. The VFDs shall have a selectable Soft Stall feature. The microprocessor shall monitor the load and in the event of an overload it shall, based on the microprocessors calculation of a true inverse time overload characteristic, either phase back the output voltage and frequency or trip as selected by an internal jumper.

D. PWM Carrier Frequency Switching, 1.5 kHz to 10 kHz, selectable.

E. The VFDs shall be capable of PID set point control, and shall provide a means for
scaling output response to the process control signal using arbitrary values to set zero and span points.

F. Each VFD shall be controlled by an independent 4-20mA signal.

G. Provide a separate pressure transmitter for each pump.

2.5 Protection

A. Base drive signals to control firing of the power transistors shall be designed with optically coupled isolators for maximum protection of the control circuits from high voltage and noise.

B. The VFDs shall contain the following protective functions, compliant with the latest effective edition of IEEE 519:

1) Stall Prevention
2) Current Limit
3) Overcurrent
4) Overvoltage
5) Short Circuit at Load
6) Ground Fault
7) Under-voltage (shuts down unit)
8) Momentary Power Interrupt
9) Electronic Thermal Overload
10) Internal Overcurrent at Start-up
11) Load Overcurrent at Start-up
12) Regenerative Discharge Resistor Overcurrent
13) Internal Over-temperature (shuts down unit)
14) Emergency Stop
15) Dual Ramp Down feature including a check valve ramp down and a final ramp feature.

C. Stall prevention and electronic thermal overload activation levels shall be adjustable and set to match the characteristics of the driven motor.

D. All circuit boards shall be provided with a factory applied solvent based conformal
coating. Minimum dry coating thickness shall be 50um. Coating shall be removable by stripping chemicals to allow for field repairs. Coatings requiring mechanical abrasion for removal will not be allowed.

2.6 Digital Indication of Fault

A. Should a VFD shut down as the result of a fault condition, an alphanumeric LED display on the VFD shall indicate the cause of the failure. Display of the failure shall include and differentiate among the following:

1) Overcurrent: Also indicates inverter status at time of fault, and further determines whether the failure is internal or external if occurring at start-up.

2) Overvoltage: Includes separate indication if the condition is detected during deceleration.

3) Overload: Indication of Motor Overload.

4) Ground Fault: Detects Ground Fault Current in the VFD load side circuit.

5) Emergency Stop: Executed from VFD keypad, separate indications for manual and automatic function at time of Emergency Stop.

6) Command Error: Indicates frequency setting signal error.

7) Memory Failure: Includes separate indications for main CPU and keypad. CPU, and further indicates whether failure was found in RAM or ROM.

8) EEPROM Error: Separate indications for data and set value abnormalities.


10) Under-voltage: Separate indications for input power and DC main circuit under-voltage.

2.7 Auto Restart

A. The VFDs shall have a selectable automatic “restart upon fault” feature that will automatically cause the VFD to attempt to resume operation after the following faults.

1) Under-voltage: Restart will be attempted when voltage rises to an acceptable level following detection of an under-voltage condition.

2) Overvoltage: Restart will be attempted when voltage falls to an acceptable level following detection of an overvoltage condition.

3) Overcurrent: Three attempts to restart will be made within 30 seconds following detection of the fault. If the condition remains after the third attempt, the fault will latch and the VFD will remain stopped.
B. A restart will not be attempted for any other type of fault. Upon detection of any other fault, the VFD shall immediately stop operating, activate the fault relay and display the appropriate fault indication.

2.8 Ride Through

A. An under-voltage condition, of less than 30mS duration, shall not affect drive operation. If main power falls below 85% of rated voltage for longer than 30mS, while control power is retained, the drive will forcibly decelerate the load in an attempt to raise the DC bus voltage through regeneration. This feature may allow the drive to ride through the under-voltage condition for 70mS; but it is dependent upon the connected inertia.

2.9 Operational Functions

A. Acceleration and Deceleration: Independently adjustable 0.1 to 300 seconds.

B. Volts: Hertz Ratio: Selectable, either constant V:Hz or second order non-linearity mode, both with base frequency, torque boost, and start-up frequency adjustments.

C. Signal Follower: 0-5 VDC

0-10 VDC

0-20 mADC

4-20 mADC

D. Min. And Max. Speed Indication: Open collector outputs activated at speed set points.

2.10 VFD Alternator Cabinet

A. The VFD Alternator Cabinet shall be provided with following:

B. VFD Alternator Cabinet shall be labeled to meet UL-508A, shall be listed as a complete assembly, and shall have a Manufacturer’s label indicating short circuit current rating.

C. Integral isolation bypass contactors (mechanically interlocked) as required to ensure pump motor is powered from alternating VFD sources each time the pump motor is called to run and to prevent back feeding the second VFD.

D. An alternator shall be provided to alternate between the two VFDs.

E. Enclosure door shall have, at minimum, the following components:

1) “Hand – Off – Auto” Selector Switch

2) “VFD-#A – Alt – VFD-#B” Selector Switch
3) “VFD-#A Running” Pilot Light

4) “VFD-#B Running” Pilot Light

F. Indicator pilot lights shall be heavy-duty, oil-tight, 30mm, push-to-test, LED lamp, with varistor type surge suppressors.

3. Execution.

3.1 Work Included

A. The supplier for VFDs and related equipment shall be responsible for coordination of the VFDs with the pump motors, the PLC, station control center, with the level and pressure sensing systems, and with the electrical service as shown on the Contract Drawings and in Section 13329.

B. Overall system responsibility shall include programming, calibration, field testing, startup training, and successful operation of the equipment.

3.2 Manufacturer’s Recommendations

A. Installation procedures shall be in accordance with the recommendations of the manufacturer of the VFD’s.

3.3 Field Test

A. The equipment shall be tested in operation in the presence of the OWNER and ENGINEER to demonstrate compliance with specification requirements.

3.4 Manufacturer’s Representative

A. Provide manufacturer’s representative in accordance with Section 01650.

END OF SECTION
Section 15170 – Level, Pressure, and Intrusion Sensing Systems

1. General.

1.1 Summary

A. This section addresses the work related to furnishing and installing all supervision, labor, materials and equipment in the work for and functionality of equipment that senses liquid level, discharge pressure, intrusion alarms and transmits that information to the pump controlling equipment and PLC. The wet well level sensing system shall control starting, stopping and, when appropriate, the rotational speed of the pumps. Pressure sensing systems may be used to control the rotational speed of pumps.

B. Related sections

01600 Materials and Equipment
01650 Starting of System
13329 Sequence of Operation
15163 Variable Frequency Drives
15160 Diesel-Engine Driven Emergency Pumping System
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16260 Motor Controllers
16310 Motor Control Panel

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

2. Products.

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Level Sensing Systems

A. Level Sensing Systems shall be as shown on the Contract Drawings

B. Bubbler Type Level Sensing System

1) Provide complete purged air-bubbler type system for sensing the liquid level in the wet well of the pumping station, which will generate and transmit level measurement signals to electromagnetic relays and / or PLCs as applicable. These relays shall, in turn, direct the start, stop and, where appropriate, speed control of sewage pumps. The bubbler system shall include an air supply system, a combination air pressure regulator and filter with low pressure gauge, air rotameter, manual alternator for air compressors, pressure switches, indicating-
type level control gauge, and all necessary timers, relays, pushbuttons and indicating lights. Wet well level Sensing system components shall include:

2) Air Supply System

(a) A minimum of two (2) air compressors suitable for bubbler system air supply shall be furnished and wired in such a manner that one (1) air compressor shall be capable of continuous operation to deliver free air at a rate of approximately 5 cubic feet per hour at a pressure not to exceed 7 psi. Each air compressor shall be wired and plumbed in a manner that will allow either air compressor to be removed from service, while the other remains in operation. A selector switch, mounted on the face of the panel, will be provided to select either compressor for operation. These compressors shall be mounted on top of the control panel cabinet for ease of access and maintenance.

(b) Each air compressor discharge line shall be connected to a brass 3-way ball valve. Valve shall be plumbed in to air compressor line. Valve shall be suitable for 1,000 psig. An air selector switch, mounted on the face of the panel, shall be provided to select either compressor as the source of air for the system.

(c) A rotameter (flow gauge) shall be furnished to indicate rate of bubbler line air flow in standard cubic feet per hour (SCFH) with a range of 0-5.0 SCFH. It shall have a corrosion resistant body and an inlet needle valve. Rotameter shall be 6 ½-inch. Floats shall be stainless steel with stainless steel spring float stops. O-rings shall be Buna-N. Accuracy of meter shall be 3 percent of full scale. Flush mounting of the gage will not be permitted. The gage shall be surface mounted on the front of the control panel so that the cap on the top of the gage can be removed without removing the gauge from the control panel.

(d) A wrench plate shall be provided to protect the diaphragm from rough handling. Pressure switch adjustment shall be easily accessible, with front mounted, self-locking adjustment screws. Each adjustment screw shall have a calibrated dial to lock-in the air adjustment. A cover shall be provided over the adjusting screws, which can be closed and sealed to prevent tampering while still allowing full view of the set point on the dial. Repeatability of the pressure setting shall be +1/2%.

(e) Bubbler air line shall be 3/8"-inch diameter Black High Density Polyethylene tubing from panel to wet well in 1" PVC conduit. Bubbler riser pipe inside wet well shall be Schedule 80 1-½" PVC, installed as shown on Contract Drawings. It shall be furnished and installed by the CONTRACTOR.

(f) Provide an air/water separator in the air line at the control panel, Air/water separator shall be mounted on an exterior bottom side of the control panel. Tubing shall be one continuous run from control panel to wet well ladder.

(g) Liquid level control systems utilizing air compressors delivering greater quantities of air at higher pressures, requiring pressure reducing valves, rate
of flow control valves and air storage reservoirs, shall not be acceptable.

3) Pressure Transmitter

(a) Pressure transmitter for wet well level shall have an analog output directly proportional to wet well level which shall be attached to the bubbler tube.

(b) Pressure transmitter for wet well level shall have a range of 0 – 10 PSID. Pressure transmitter for VFD speed control shall have a range of 0 – 100 in. W.C.

(c) Pressure transmitter shall consist of a Linear Voltage Differential Transformer (LVDT) whose core is positioned by a direct connection to a pressure bellows. No springs, levers or other devices or methods, which may be affected by changes in ambient temperature, wear or fatigue, will be acceptable. The transducer circuitry shall be entirely solid state and shall provide independent and non-interacting adjustments of offset and span. Pressure actuated potentiometers or other devices, which may introduce hysteresis or which may wear, will be unacceptable.

C. Submersible Level Transmitters

1) Submersible level transmitters shall convert hydrostatic pressure to wet well level and shall have an analog output directly proportional to wet well level.

(a) Range selected shall be the manufacturer's standard range closest to the span to be measured from the bottom of the wet well to the wet well top slab as shown on the Contract Drawings.

(b) Temperature Compensation: Temperature compensated over a range of zero to 122 degrees F.

(c) Accuracy: Plus or minus 0.25 percent of range.

(d) Over Pressure: Transmitter shall be protected for over pressure of 2.0 times full scale output

(e) Output: 4-20 mA proportional to the calibrated span.

2) Physical:

(a) Construction: Type 316 stainless steel body with a bottom diaphragm.

(b) Transmitter shall be suspended by cable. Cable shall include a vent tube for the transmitter. Provide sufficient manufacturer's cable for installation shown on the Contract Drawings. Cable shall be reinforced to support the weight of the transmitter and cable.

(c) Transmitter shall be suspended with a tension-relieving mounting clamp from a four-inch (100 mm) flange. Clamp and flange shall be Type 316 stainless steel.
(d) Transmitter shall be certified intrinsically safe.

(e) 24 VDC loop powered.

D. High Water Level Alarm Sensing Equipment

1) High water alarm sensing equipment shall be independent of any other system installed in the station. High water alarm float shall be installed in the wet well, dry well and/or valve vault as shown on the Contract Drawings.

2) Alarm shall be a direct acting mercury float switch. Three conductor (14 AWG - 105 strands per inch), manufactured especially for underwater use, shall be secured with stainless steel clamps and anchors. The float shall be installed in the normal “closed” position.

3) The following equipment shall be furnished and installed by the CONTRACTOR:

   (a) Alarm/Status Interface Package to connect floats and sensors to OWNER - furnished radio alarm transmitter.

4) Float Switches

   (a) A mechanical normally closed micro switch in a plastic casing, with a minimum AC resistive load of 250V 10A and an inductive load of 250V 3A. With a 3-wire, oil resistant flexible cord of the length required to run un-spliced from the float switch to alarm panel.

   (b) Float shall be a mechanical switch in a plastic casing freely suspended at the desired height from its own cable. The casing shall be made of polypropylene and the cable shall be sheathed with a PVC or Nitrile/PVC rubber Compound. The counter weight shall also be encased in the plastic casing.

2.3 Discharge Pressure Sensing System

A. Provide a pressure sensor and pressure transmitter to measure discharge force main pressure as shown on the Contract Drawings. This sensing system shall transmit pressure signals to the PLC and / or pump VFDs.

B. Pressure Sensor

1) Wafer Style

   (a) Pressure sensor to be wafer type designed to fit between ANSI B16.1 Class 125 pipe flanges. Sensor shall be flow through design with flexible elastomer sensing ring around the full circumference. The sensing ring shall be fluid filled to transfer pressure to the gauge and pressure transmitter.

   (b) Non wetted body shall be stainless steel

   (c) Elastomer shall be Buna-N
(d) The pressure sensor shall measure pressure for the full circumference of the sensor. The sensor shall be capable of measuring pressure from 0 psi – 100 psi.

2) Threaded Style

(a) Pressure sensor shall have threaded national pipe thread ends.

(b) Pressure sensor shall be all 316 stainless steel construction.

(c) The sensing ring shall be fluid filled with silicone oil.

(d) Elastomer shall be Buna-N.

C. Pressure Transmitter

1) Pressure transmitter exterior and wetted parts shall be stainless steel.

2) Pressure transmitter shall have a 1/4” NPT threaded pressure port. Output signal shall be 4-20 mA through a two-conductor cable.

3) Pressure transmitter shall be capable of sensing pressure from 0 psi – 100 psi at an operating temperature range of 0 F to 200 F with an accuracy of +/- 0.25% of the full-scale output and will send an output signal to a digital readout on the face of the control panel.

2.4 Pressure and Vacuum Gauge Assemblies

A. Pressure gauges shall be installed on the pump volute for dry pit pumps.

B. For suction lift stations, pressure gauges will be installed on discharge piping directly downstream of the pump.

C. Vacuum gauges will be installed on the suction piping of suction lift stations between wet well and check valve.

D. Gauge Assembly: Consists of gauge; ½ inch gauge piping; ball valves for shut-off and blow-off; diaphragm seal and pulsation dampener. Provide as indicated below:

1) Gauge: ASME B40.1 Grade 2A, liquid-filled. 0 to 100 PSI.

2) Vacuum - range liquid filled . 0 to -30 in Hg

3) Case and Ring: Phenolic or polypropylene case with polypropylene threaded ring.

4) Window: Acrylic.

5) Size: 2 inch diameter face.

6) Bourdon Tube: Phosphor bronze.
7) Socket: Brass ½ inch NPT.
8) Movement: Stainless steel, rotary geared.
9) Dial: White background with black graduations and figures.
10) Pointer: Aluminum, black finish, micro adjustable.
11) Accuracy: Plus or minus ½ percent.
12) Scale and Graduations: See Schedule look up graduations.
13) Filler Material: Glycerin.

E. Pulsation Damper: Of material suitable for process medium being handled.

F. Diaphragm Seal: Continuous duty, removable type.
   1) Diaphragm: Rubber
   2) Housing: 316 stainless steel, with 1/2 inch NPT gauge connection and ½ inch NPT process connection, and lower housing flushing connection.
   3) Filler Material: Glycerin.

G. Gauge Piping:
   1) Pipe: Carbon steel, Schedule 40, ASTM A53, Grade B.
   2) Fittings: Malleable iron, Class 250, ANSI B16.3, threaded.
   3) Ball Valves: Brass with lever handle, minimum 200 psig.

2.5 Intrusion Sensor
   A. Magnetic door alarm sensor to connect entryway door with alarm system to alarm the opening of the entryway door.

3 Execution
   3.1 Installation - Bubbler-type wet well level sensing system
   A. The CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide, test and place into operation the bubbler-type wet well level sensing system with related equipment and accessories for transmission of level signals to the pump control panel, and, when appropriate, to the variable frequency drives.
   B. The bubbler type wet well level sensing system shall be installed in accordance with the requirements on the Contract Drawings.
3.2 Installation - Submersible Level Transmitter

A. The CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide, test and place into operation the submersible level transmitter type level sensing system with related equipment and accessories for transmission of level signals to the pump control panel, and, when appropriate, to the variable frequency drives.

B. The submersible level transmitter shall be installed in a stilling well in accordance with the requirements on the Contract Drawings.

C. Install and connect the submersible level transmitter level sensing system in motor control panel in strict accordance with the requirements of the manufacturer.

3.3 Installation – Discharge Pressure Sensing System

A. The CONTRACTOR shall furnish all labor, materials, equipment and incidentals required to provide, test and place into operation the Discharge Pressure Sensing system with related equipment and accessories for transmission of discharge pressure signals to the pump control panel, and, when appropriate, to the variable frequency drives.

B. The discharge pressure sensing system shall be installed in accordance with the requirements on the Contract Drawings.

C. Install and connect the Discharge Pressure Sensing System in motor control panel in strict accordance with the requirements of the manufacturer.

3.4 Installation - Float Switches

A. The float shall be freely suspended at the desired height from its own cable.

1) In Dry Well or Valve Vault locations, the float shall be secured so that it is 6 inches off of the floor and is positioned so that it can tilt without any interference from ladders, pipes, or other equipment.

2) In Wet Well locations, the float shall be secured at the top of the wet well ladder away from the wall so that it can be freely suspended to the height of 6 inches below the inflow of the wet well or 1 foot below the platform whichever is lower.

B. Terminate float wiring using normally-closed configuration as required for proper operation. Cap the unused third wire in the control panel or PLC cabinet.

C. All piping shall use seal offs and be plugged with sealant to prevent the gasses from the wet well from entering the first pull/junction box located in the station. These seal offs shall be located in the station with easy access; they are not to be located in the wet well.
3.5 Installation – Alarm System

A. The CONTRACTOR shall furnish and install a complete alarm sensing system as shown on the Contract Drawings.

B. All equipment shall meet or exceed F.C.C. regulations. Equipment installation and adjustment shall be in strict accordance with all F.C.C. rules governing the system specified herein.

C. All work shall conform to all local codes and ordinances and shall operate with the central alarm receiving system of the City of Virginia Beach.

D. The OWNER will provide and install a Remote Terminal Unit (RTU) (Radio Alarm Transmitter) complete with PLC and antenna cable after CONTRACTOR notifies the OWNER that the alarm system and sensing devices are ready for connection. The CONTRACTOR shall provide all connections at the locations shown on the Contract Drawings.

3.6 Manufacturer’s Recommendations

A. Installation procedures shall be in accordance with the recommendations of the alarm system manufacturer.

END OF SECTION
Section 15492 – Fuel Gas Piping

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing fuel gas piping.

B. Related sections

01600 Materials and Equipment
01650 Starting of System
09900 Painting
16620 Engine Generators

1.2 **Submittals**

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Submittal data shall include the following:

1) Manufacturer’s Catalog Data
   
   (a) Pipe and fittings
   
   (b) Hangers and supports
   
   (c) Gas equipment connectors
   
   (d) Valves
   
   (e) Warning and identification tape
   
   (f) Risers
   
   (g) Transition fittings

2) For Polyethylene (PE) pipe and fittings – Submit manufacturer’s installation instructions and manufacturer’s visual joint appearance chart.

3) Statements
   
   (a) Welder’s qualifications
   
   (b) PE welder’s qualifications
   
   (c) Welder’s identification symbols
   
   (d) Submit a copy of a certified ASME B31.8 qualification test report for each
welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder.

4) Certificates
   (a) PE pipe and fittings
   (b) Transition fittings

5) Permits
   (a) Submit copies of all required permits to the OWNER.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)
   1) ANSI Z21.41 - Standard for Quick-Disconnect Devices for Use with Gas Fuel Appliances
   2) ANSI Z21.45 - Flexible Connectors for Other than All-Metal Construction for Gas Appliances

C. American Society of Mechanical Engineers (ASME)
   1) ASME/ANSI A13.1 - Scheme for the Identification of Piping Systems
   2) ASME/ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form)
   3) ASME/ANSI B1.20.1 - Pipe Threads, General Purpose (Inch)
   4) ASME/ANSI B16.3 - Malleable Iron Threaded Fittings
   5) ASME/ANSI B16.5 - Pipe Flanges and Flanged Fittings
   6) ASME/ANSI B16.9 - Factory-Made Wrought Steel Butt-Welding Fittings
   7) ASME/ANSI B16.11 - Forged Steel Fittings, Socket-Welding and Threaded
   8) ASME/ANSI B16.33 - Manually Operated Metallic Gas Valves for use in Gas Piping Systems up to 125 psig (Sizes 1/2 through 2)
   9) ANSI/ASME B16.38 - Large Metallic Valves for Gas Distribution (Manually Operated, NPS 2-1/2 to 12, 125 psig Maximum)
  10) ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300

12) ASME/ANSI B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

13) ASME/ANSI B18.2.2 - Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

14) ASME B31.8 - Gas Transmission and Distribution Piping Systems

15) ASME BPVC SEC VIII D1 - Boiler and Pressure Vessel Code: Section VIII Rules for Construction of Pressure Vessels, Division 1

D. American Society for Testing and Materials (ASTM)

1) ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

2) ASTM A 193/A 193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High-Pressure Service, and other Special Purpose Applications

3) ASTM A 194/A 194M - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

4) ASTM D 2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings

5) ASTM D 2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

E. Commercial Item Description (CID)

1) A-A-1689B - Tape, Pressure-Sensitive Adhesive (Plastic Film)

F. Code of Federal Regulations (CFR)

1) 49 CFR PT 192 - Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

G. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

1) MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

H. National Fire Protection Association (NFPA)

1) NFPA 54 - National Fuel Gas Code
I. State of Virginia

1) VFGC - Virginia Fuel Gas Code

1.4 Quality Assurance

A. Prior to installation, CONTRACTOR shall have supervising and installing personnel, certified in accordance with paragraph entitled "Welder's Qualifications" below.

B. Welder's Qualifications: Comply with ASME B31.8. The steel welder shall have a copy of a certified ASME B31.8 qualification test report. The PE welder shall have a certificate from a PE pipe manufacturer's sponsored training course. CONTRACTOR shall also conduct a qualification test. Submit each welder's identification symbols, assigned number, or letter, used to identify work of the welder. Affix symbols immediately upon completion of welds. Welders making defective welds after passing a qualification test shall be given a requalification test and, upon failing to pass this test, shall not be permitted to work this contract.

C. PE Welder's Qualifications: Prior to installation, CONTRACTOR shall have supervising and installing personnel trained by a PE pipe manufacturer's sponsored course of not less than one week duration, or present proof satisfactory to the OWNER that personnel are currently working in the installation of PE gas distribution lines.


1.5 Delivery, Storage, and Handling

A. Handle, transport, and store pipe and fittings carefully. Plug or cap pipe ends during transportation or storage to minimize dirt and moisture entry. Do not subject pipe materials to abrasion or concentrated external loads. Discard pipe sections and fittings that have been damaged.

2. Products

2.1 Materials and Equipment

A. Conform to NFPA 54, VFGC, and with requirements specified herein. Supply piping to appliances or equipment shall be at least as large as the inlets thereof.

2.2 Pipe and Fittings

A. Aboveground

1) Pipe: Black steel in accordance with ASTM A53, Schedule 80, threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.


4) Butt-Welding Fittings: ASME/ANSI B16.9, with backing rings of compatible material.


6) Flanges and Flanged Fittings: ASME/ANSI B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

B. Underground Polyethylene (PE)

1) PE pipe and fittings are as follows:
   (a) Pipe: ASTM D 2513, 100 psig working pressure, Standard Dimension Ratio (SDR), the ratio of pipe diameter to wall thickness, 11.5 maximum.
   (b) Socket Fittings: ASTM D 2683.
   (c) Butt-Fusion Fittings: ASTM D 2513, molded.

C. Risers: Manufacturer's standard riser, transition from plastic to steel pipe with 7-to-12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide remote bolt-on or bracket for wall-mounted riser supports.

D. Transition Fittings Steel to PE: As specified for "riser" except designed for steel-to-plastic with tapping tee or sleeve. Coat or wrap exposed steel pipe with heavy plastic coating. Steel shall be entirely above grade with plastic sleeve protecting plastic pipe if exposed.

2.3 Valves, Aboveground

A. Shutoff Valves, Sizes 2 Inches and Smaller - Bronze body plug valve in accordance with ANSI B16.33, straightway, taper plug, regular pattern with a port opening at least equal to the internal pipe area or round port full bore pattern, non-lubricated, PTFE packing, flat or square head stem with lever operator, 125-psig rating, threaded ends.

2.4 Gas Equipment Connectors


2.5 Buried Utility Warning and Identification Tape

A. Provide detectable aluminum-foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3-inch
minimum width, color-coded yellow for natural gas, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED GAS PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.6 Hangers and Supports
   A. MSS SP-58.

2.7 Welded Filler Material
   A. ASME B31.8.

2.8 Pipe Thread Tape
   A. Anti-seize and sealant tape of polytetrafluoroethylene (PTFE).

2.9 Bolting (Bolts and Nuts)
   A. Stainless steel bolting; ASTM A 193/A 193M, Grade B8M or B8MA, Type 316, for bolts; and ASTM A 194/A 194M, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts shall conform with ASME/ANSI B18.2.1 and ASME/ANSI B18.2.2 with coarse threads conforming to ASME/ANSI B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs shall extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts shall have American Standard regular square or heavy hexagon heads; nuts shall be American Standard heavy semi-finished hexagonal.

2.10 Gaskets
   A. Fluorinated elastomer, compatible with flange faces.

2.11 Identification for Aboveground Piping
   A. Labels for pipes ¼-inch OD and larger shall bear printed legends to identify contents of pipes and arrows to show direction of flow. Labels shall have color-coded backgrounds to signify levels of hazard in accordance with ASME/ANSI A13.1. Labels shall be made of plastic sheet per CID A-A 1689B with pressure-sensitive adhesive suitable for the intended application or they may be pre-molded of plastic to fit over specific pipe outside diameter. Labels for pipes smaller than ¼-inch OD, furnish brass identification tags 1-1/2 inches in diameter with legends in depressed black - filled characters.

3. Execution

3.1 Installation
   A. Install gas piping, appliances, and equipment in accordance with NFPA 54. Install distribution piping in accordance with ASME B31.8.
B. Excavating and Backfilling: Place pipe directly in trench bottom and cover with minimum 3 inches of sand above the top of pipe. If trench bottom is rocky, place pipe on a 3-inch bed of sand and cover as above. Provide remaining backfilling. Coordinate provision of utility warning and identification tape with backfill operation. Bury utility warning and identification tape with printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

C. Piping: Cut pipe to actual dimensions and assemble to prevent residual stress. Run piping parallel to structure lines. Terminate each vertical supply pipe to equipment with tee, nipple and cap to form a sediment trap. To supply multiple items of equipment, provide manifold with inlet connections at both ends.

1) Cleanliness: Clean inside of pipe and fittings before installation. Blow lines clear using 80-to-100 psig clean, dry compressed air. Rap steel lines sharply along entire pipe length before blowing clear. Cap or plug pipe ends to maintain cleanliness throughout installation.

2) Aboveground Steel Piping: Determine measurements for piping at the job site and accurately cut pipe lengths accordingly. For 2-inch diameter and smaller, use threaded or socket-welded joints. For 2-1/2 inch diameter and larger, use flanged or butt-welded joints.

(a) Threaded Joints: Where possible, use pipe with factory-cut threads. Otherwise, cut pipe ends square, remove fins and burrs, and cut tapered pipe threads in accordance with ASME/ANSI B1.20.1. Provide threads that are smooth, clean, and full-cut. Apply anti-seize paste or tape to male threads portion. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed. Use unions for connections to valves and meters for which a means of disconnection is not otherwise provided.

(b) Welded Joints: Weld by the shielded metal-arc process, using covered electrodes and in accordance with procedures established and qualified in accordance with ASME B31.8.

(c) Flanged Joints: Use flanged joints for connecting welded joint pipe and fittings to valves to provide for disconnection. Install joints so that flange faces bear uniformly on gaskets. Engage bolts so that there is complete threading through the nuts and tighten so that bolts are uniformly stressed and equally torqued.

(d) Pipe Size Changes: Use reducing fittings for changes in pipe size. Size changes made with bushings will not be accepted.

(e) Painting: Paint new ferrous metal piping, including supports, in accordance with Section 09900. Do not apply paint until piping tests have been completed.

(f) Identification of Piping: Identify piping aboveground in accordance with
ASME/ANSI A13.1, using adhesive-backed or snap-on plastic labels and arrows. In lieu of labels, identification tags may be used. Apply labels or tags to finished paint at intervals of not more than 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.

3) Buried Plastic Lines: Provide PE piping only. Prior to installation, obtain printed instructions and technical assistance in proper installation techniques from pipe manufacturer.

   (a) PE Piping: Provide fusion-welded joints, except where transitions have been specified. Use electrically heated tools, thermostatically controlled and equipped with temperature indication. Where connection must be made to existing plastic pipe, CONTRACTOR shall be responsible for determination of compatibility of materials and procedural changes in fusion process necessary to attain maximum integrity of bond.

   (b) Laying PE Pipe: Bury pipe 24 inches below finish grade or as indicated, whichever is deeper. Lay in accordance with manufacturer's printed instructions.

4) Wrapping: Where connection to existing steel line is made underground, tape wrap new steel transition fittings and exposed existing pipe having damaged coating. Clean pipe to bare metal. Initially stretch first layer of tape to conform to the surface while spirally half-lapping. Apply a second layer, half-lapped and spiraled as the first layer, but with spirals perpendicular to first wrapping. Use 10-mil minimum thick polyethylene tape. In lieu of tape wrap, heat shrinkable 10-mil minimum thick polyethylene sleeve may be used.

D. Valves: Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally. Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

E. Hangers and Supports: Selection, fabrication, and installation of piping hangers and supports shall conform to MSS SP-58, unless otherwise indicated.

F. Final Connections: Make final connections to equipment using flexible pipe and fittings.

3.2 Field Quality Control

A. Metal Welding Inspection: Inspect for compliance with NFPA 54. Replace or repair, and then re-inspect defective welds.

B. PE Fusion Welding Inspection: Visually inspect butt joints by comparing with manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints and re-joining or replacing fittings. Inspect 100 percent of all joints and re-inspect all corrections. Arrange with the pipe manufacturer's representative, in the presence of the OWNER, to make first time inspection.

C. Pressure Tests: Use test pressure of 1-1/2 times maximum working pressure, but in
no case less than 50 psig. Do not test until every joint has set and cooled at least 8 hours at temperatures above 50 degrees F. Conduct testing before backfilling; however, place sufficient backfill material between fittings to hold pipe in place during tests. Test system, gas tight, in accordance with NFPA 54. Use clean dry air or inert gas, such as nitrogen or carbon dioxide, for testing. Systems, which may be contaminated by gas, shall first be purged as specified. Make tests on entire system or on sections that can be isolated by valves. After pressurization, isolate entire piping system from sources of air during test period. Maintain test pressure for at least 8 hours between times of first and last reading of pressure and temperature. Take first reading at least one hour after test pressure has been applied. Do not take test readings during rapid weather changes. Provide temperature same as actual trench conditions. There shall be no reduction in the applied test pressure other than that due to a change in ambient temperature. Allow for ambient temperature change in accordance with the relationship $PF + 14.7 = (P1 + 14.7) \frac{(T2 + 460)}{(T1 + 460)}$, in which "T" and "PF" represent Fahrenheit temperature and gage pressure, respectively, subscripts "1" and "2" denote initial and final readings, and "PF" is the calculated final pressure. If "PF" exceeds the measured final pressure (final gage reading) by 1/2 psi or more, isolate sections of the piping system, retest each section individually, and apply a solution of warm soapy water to joints of each section for which a reduction in pressure occurs after allowing for ambient temperature change. Repair leaking joints and repeat test until no reduction in pressure occurs. In performing tests, use a test gage calibrated in one-psi increments and readable to 1/2 psi.

D. System Purging: After completing pressure tests, and before testing a gas contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Clear completed line by attaching a test pilot fixture at capped stub-in line at building location and let gas flow until test pilot ignites. Procedures shall conform to NFPA 54.

CAUTION

Failure to purge may result in explosion within line when air-to-gas is at correct mixture.

END OF SECTION
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing complete electric space heating and ventilating systems as shown or specified.

B. Related sections

01600 Materials and Equipment
01650 Starting of System
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods

1.2 **Submittals**

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Submittal Data shall include the following:

1) Letters of transmittal listing all shop drawings enclosed and the intended purpose of each item.

2) Complete physical data and certified performance data.

3) Non-complying features and reason for non-compliance in detail.

C. Partial submittals, or submittals of less than the whole of any system made of interdependent components, will not be considered.

D. Prior to final acceptance testing, submit certified testing, adjusting and balancing (TAB) report for review.

E. Operations and Maintenance Manual in accordance with Section 01600.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. Virginia Uniform Statewide Building Code

D. Virginia Statewide Fire Prevention Code

E. Virginia Department of Environmental Quality (DEQ) Sewage Collection and Treatment Regulations (SCAT)
F. Underwriters Laboratories, Inc. (UL)

G. National Fire Protection Association (NFPA)

H. Air Movement and Control Association (AMCA)
   1) AMCA 99-0401 – Classification for Spark Resistant Construction

I. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

J. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

K. Associated Air Balance Council (AABC)

L. National Environmental Balancing Bureau (NEBB)

1.4 Plans and Specifications

A. The Contract Drawings are diagrammatic and indicate the general extent, character and arrangement of equipment, ductwork, piping and control systems. If any departures from the Contract Drawings are deemed necessary, CONTRACTOR shall submit details of such departures and the reasons therefore, as soon as practicable after award of the contract, to the OWNER for approval. No such departures shall be made without prior written approval of the OWNER. It is the intention of these Contract Drawings and specifications to fully cover all work and materials for a complete first-class installation.

1.5 Service, Inspection and Tests

A. CONTRACTOR shall show evidence that a factory authorized local service organization is in existence to service and furnish spare and replacement parts for all equipment under this Section of the Specifications. The right is reserved to inspect and test any portion of the equipment during the progress of its installation. The CONTRACTOR shall secure and pay for all required permits and inspections. Inspection certificates from local authorities having jurisdiction shall be delivered to the OWNER before final payment.

B. Provide Operational Testing per the requirements of Section 01650.

2. Products

2.1 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Unit Heater

A. Propeller unit heater shall be of the forced convection type, securely fastened in an approved manner, and shall consist of fan, motor side guard, mounting bracket, heating elements, and housing. Housing shall be reinforced steel fitted with
adjustable horizontal louvers to permit directing the heated air where desired. All ferrous parts shall be treated to prevent rusting in corrosive atmosphere before application of a baked enamel finish. Electrical heating elements shall be of fin tube type of specified KW rating, with continuous spiral fins permanently brazed to a metal sheath. Motor shall be totally enclosed, continuous heavy-duty type, designed for all-angle operation, with built-in thermal overload protection and with sleeve or ball bearings. Fan wheels shall be aluminum bladed Q wheels direct-connected to fan motor of specified design for efficient electric heater performance, dynamically balanced by manufacturer. Operating and capacity characteristics shall be as shown on the Contract Drawings. Thermostat for electric heater shall be wall mounted and shall have an approximate range from 40 to 90 degrees F and operating differential of 3 degrees F or less.

2.3 Ventilating Fans

A. Ventilating Fan Sizing:

1) Wet well fans shall be sized to provide a minimum of 30 air changes per hour based on the volume of the wet well per the requirements of the Virginia DEQ SCAT Regulations for intermittent fan operation.

2) Dry well fans shall be sized to provide a minimum of 30 air changes per hour based on the volume of the dry well.

3) Electrical room fans shall be sized to provide a maximum temperature rise of 10°F above ambient conditions based on the heat gains associated with the building skin loads from the roof, walls, windows, doors, etc.; and the heat gains to the space from the duty/operating electrical equipment located in the space.

B. Wet well and dry well ventilating fans shall be constructed to meet the intent of AMCA 99-0401 for spark-resistance B construction, and provided with explosion-proof motors. Wet well and dry well ventilating fans shall be axial or centrifugal inline type with belt drive motor; or centrifugal roof mount type with direct drive or belt drive motor, manufacturer’s roof curb, and discharge bird screen, as indicated. Housing for inline fans shall be seamless and sealed. Belt drive pulley shall be adjustable. Belts, drives, sheaves, and shaft shall be isolated from the airstream contaminants in totally enclosed compartments. Inline fan and components shall allow for vertical or horizontal mounting. Provide belt drive fans with belt guard. Fans shall be provided with gravity dampers. Bearings shall be provided with extended lube lines. Bearings and lube lines shall be pre-filled with manufacturer’s recommended lubricant. Fan assembly shall have removable covers to allow for access. Fans constructed with inlet cones shall be provided with inlet drains that drain back into the airstream. Provide fans with inlet (and outlet for inline) taper construction of non-corrosive material (galvanized steel will not be acceptable), to provide transition from fan to inlet duct and outlet duct. Provide with integral disconnect.

1) Wet fan control shall be a manual on/off switch.

2) Dry well fan control shall be a programmable timer - multipurpose control 24-hour time switch. Timer shall have a minimum of 20 on/off set points, repeatable
each day with a minimum setting of 1-minute, automatic daylight savings time adjustment, automatic leap year compensation, manual override, one channel, SPST output dry contacts, and power outage backup with permanent schedule retention and 4 days of real time backup. Input voltage shall be 120 VAC/60 Hz. Operating temperatures shall be -31°F to 116°F. Enclosure shall be polycarbonate indoor/outdoor NEMA 3R, with lockable hasp. An override On-Off switch shall also be provided to override the timer and allow the fan to operate continuously.

C. Electrical room fans shall be wall mounted propeller fans. Wall propeller fans shall be provided with AMCA seal. Provide direct-drive motor. Provide with fan guard, integral disconnect, wall sleeve, fan speed controller, and combination shutter and gravity damper. Propeller shall be statically and dynamically balanced. Fan size and capacity shall be as specified on the Contract Drawings.

1) Electrical room fan control shall be a programmable timer - multipurpose control 24-hour time switch. Timer shall have a minimum of 20 on/off set points, repeatable each day with a minimum setting of 1-minute, automatic daylight savings time adjustment, automatic leap year compensation, manual override, one channel, SPST output dry contacts, and power outage backup with permanent schedule retention and 4 days of real time backup. Input voltage shall be 120 VAC/60 Hz. Operating temperatures shall be -31°F to 116°F. Enclosure shall be polycarbonate indoor/outdoor NEMA 3R, with lockable hasp. An override On-Off switch shall also be provided to override the timer and allow the fan to operate continuously.

D. Gravity Dampers shall be factory-fabricated, with statically balanced and adjustable weighted blades that open automatically when fan starts and close by gravity when fan stops. Provide edges of blades with felt or rubber strips to prevent rattling. Construct with extruded aluminum with center pivoted blades linked together. Provide suitable mounting bracket.

2.4 Louvers

A. Louvers shall bear AMCA certified ratings program seal for air performance and water penetration. Maximum pressure drop shall be 0.1 inch W.G. Louvers shall have maximum water penetration of 0.0 ounce per square foot of free area at free velocity of 700 fpm. Provide aluminum alloy with anodized (brown) finish frames and blades assembled with stainless steel screws, including mesh aluminum screen mounted in extruded aluminum frame. Provide with gravity dampers as specified in 2.3 (C) where indicated.

2.5 Ductwork

A. Ductwork and accessories shall conform to SMACNA requirements for low pressure ducts. (2” WG, seal Class B)

B. Unless otherwise indicated ductwork shall be corrosion resistant CPVC (Sch 40) pipe. Miscellaneous fasteners and mounting hardware shall be stainless steel. Construction details shall conform to HVAC Duct Construction Standards as published by Sheet Metal and Air Conditioning Contractor’s Association, Inc.
C. Fasteners, plenums, boxes and other manufactured transition pieces shall be fabricated of aluminum or stainless steel.

D. Erect ductwork in a first-class, workmanlike manner secured in place rigidly and permanently. Provide suitable hangers, securely attached to building construction with bolts, clips, or inserts. Hangers shall be structural shapes, flat bars, or formed strap hangers; use of wire will not be permitted. Hangers shall not pass through or be inside duct. All space around ducts where they pass through any walls, ceilings, or roofs shall be sealed tight with noncombustible inert material. Provide flanged collars around exposed ducts passing through walls, or ceilings in finished areas to provide a finished appearance.

E. Flexible connections or neoprene or other NFPA approved non-flammable fabric shall be provided in duct system at all fan connections.

3. **Execution.**

3.1 **Manufacturer’s Recommendations.**

A. Installation procedures shall be in accordance with the recommendations of the manufacturer of the equipment being furnished.

3.2 **Ductwork Installation**

A. Coordinate ductwork with other work and install ducts at proper elevations and locations to maintain indicated ceiling heights and clearances. Provide all elbows, transitions, offsets, connections, and other fittings necessary to fit the work into place or to connect to equipment.

B. Substantially support ductwork with structural shapes, flat bars, or formed strap hangers securely attached to the building structure by means of bolts, clamps, or inserts. Support vertical ducts by brackets or hangers attached to the building structure. Strap hangers shall be stainless steel. Use square ¼” thick washers tight against the bend on upper strap attachments to horizontal surfaces. Place all supports external to the ductwork and out of the air stream. Arrange supports so that duct weight is not transmitted to fans.

C. Prevent direct contact between ductwork and building surfaces or other equipment. Where ducts pass through walls, partitions, floors, ceilings, or roofs, pack and seal the space around the duct with an approved fire-safe inert material.

D. Use stainless steel hangers, supports, brackets, and hardware.

E. Furnish and install NFPA approved duct connections where shown and at all connections to fans. Use glass-reinforced neoprene fabric, roll-formed to flanges. Support adjacent ductwork to provide sufficient slack in the connection.

3.3 **Performance Testing**

A. Before final acceptance of the work, test each system as in service to demonstrate compliance with the Contract Drawings and testing as specified in the local
mechanical code.

B. Refer to Section 016150 for Operational Testing requirements.

3.4 Code Installation

A. Equipment which is required by code or is specified to have UL or similar listing, shall be installed as required to meet that listing.

3.5 Testing, Adjusting, and Balancing (TAB)

A. Balance air side systems related to scope of work. Certified balance reports shall be furnished to the OWNER for review and approval. Report format and procedure shall be in accordance with AABC or NEBB requirements by an AABC or NEBB Certified Professional.

B. Supply and install sheaves as necessary for final balancing.

END OF SECTION
Section 16010 – Electrical General Requirements

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing, installing and providing complete electrical systems as shown on the Contract Drawings and specified in these sections of the specifications.

B. Related sections

01600 Materials and Equipment
02060 Building and Structure Demolition
09900 Painting
15100 Vertical Extended Shaft Centrifugal Pumping Equipment
15150 Non-Clog Submersible Centrifugal Pumps ad Drives
15160 Diesel-Engine Driven Emergency Pumping System
15163 Variable Frequency Drives
15170 Level, Pressure, and Intrusion Sensing Systems
15700 Heating and Ventilation Equipment
16050 Basic Electrical Materials and Methods
16120 Conductors and Cables
16130 Raceways, Boxes, and Fittings
16140 Wiring Devices
16170 Disconnect Switches
16260 Motor Controllers
16310 Motor Control Panel
16320 Panelboards
16330 Transformers
16340 Surge Protection Devices
16400 Electrical Service
16430 Enclosed Main Circuit Breaker
16450 Electrical Grounding System
16500 Lighting
16620 Engine Generators
16630 Automatic Load Transfer Switch

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 –Materials and Equipment.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)
D. Institute of Electrical and Electronics Engineers (IEEE)
E. Insulated Cable Engineers Association, Inc. (ICEA)
F. International Society of Automation (ISA)
G. National Electrical Code (NEC)
H. National Electrical Safety Code (NESC)
I. National Electrical Manufacturers Association (NEMA)
J. InterNational Electrical Testing Association (NETA)
K. National Fire Protection Association (NFPA)
L. Standard for Electrical Safety in the Workplace (NFPA 70E)
M. Underwriters Laboratories (UL)
N. Virginia Department of Environmental Quality (DEQ) Sewage Collection and Treatment Regulations (SCAT)
O. Virginia Statewide Fire Prevention Code (SFPC)
P. Virginia Uniform Statewide Building Code (USBC)
Q. Applicable Local Codes
R. Rules and Regulations of Local Utility Company

1.4 Drawings and Specifications

A. The Contract Drawings are diagrammatic and indicate the general extent, character and arrangement of equipment, and conduit and wiring systems. If any departures from the Contract Drawings are deemed necessary, CONTRACTOR shall submit details of such departures and the reasons therefore, as soon as practicable after award of contract, to the OWNER for approval. CONTRACTOR shall make no such departures without prior written approval of the OWNER.

B. It is the intention of these specifications and Contract Drawings to fully cover all work and materials for a complete, first-class electric installation, and any devices such as pull boxes and disconnect switches, usually employed in the class of work, though not specifically mentioned or shown on the Contract Drawings or in this specification, but which may be necessary for the satisfactory completion of the work, shall be furnished and installed by the CONTRACTOR as a part of his total work. Cooperate and coordinate with other contractors to furnish complete workable systems.

C. Carefully check space requirements to ensure that equipment, pipes, conduits, etc. can be installed in the spaces allotted for them. Where interference occurs and work
must be relocated, relocate without additional cost. All relocations must be approved by the OWNER prior to beginning the work.

D. Disagreements occurring between trades covering various phases of the work shall be referred to the General Contractor for final resolution.

E. During construction, the CONTRACTOR shall keep an accurate record of all deviations between the work as shown on the Contract Drawings and that which is actually installed. The CONTRACTOR shall secure a set of construction drawings for this purpose, and note changes thereon in red ink, in a neat and accurate manner, thus making a complete record of all changes and revisions in the original design, which exist in the completed work. The cost of furnishing above prints and preparing these record drawings shall be the responsibility of the CONTRACTOR, and shall be included in the contract price. When all revisions have been shown on these prints to indicate the work as finally installed, the prints shall be delivered to the OWNER, before final payment.

1.5 Arc Flash Coordination

A. The OWNER’s Arc Flash Consultant will review all electrical equipment shop drawing submittals.

B. The Arc Flash Consultant will prepare a preliminary technical review of equipment submitted for short circuit coordination and arc flash compliance. Recommended breaker settings will be provided to the CONTRACTOR based on the preliminary technical review.

C. The CONTRACTOR will be responsible for making equipment setting adjustments based upon the preliminary technical review. All equipment adjustments will be made in the presence of the OWNER and Arc Flash Consultant prior to the pump station being energized.

D. The CONTRACTOR shall furnish to the OWNER any interface devices required to make equipment adjustments.

E. The Arc Flash Consultant shall inspect the installed electrical equipment prior to the pump station being energized.

F. The pump station may be energized upon completion of equipment adjustments and approval from the OWNER.

G. The Arc Flash Consultant will participate with the OWNER during the Final Inspection.

H. The Arc Flash Consultant will provide appropriate Arc Flash warning labels for all electrical equipment.

I. The Arc Flash Consultant will provide the OWNER with a final arc flash report based on approved as built conditions.
1.6 Service, Inspection, and Tests
   
   A. The CONTRACTOR shall show evidence that factory authorized local service organization is in existence to service and furnish spare and replacement parts of all equipment.
   
   B. The right is reserved to inspect and test any portion of the equipment during the progress of its installation. The CONTRACTOR shall test all wiring for continuity and ground before connecting any fixtures or devices. The CONTRACTOR shall test the entire system, when the work is finally completed, to ensure that all portions are free from short circuits and grounds. All equipment necessary to conduct the above tests shall be furnished by the CONTRACTOR at its expense.
   
   C. Secure and pay for all required permits and inspections. Inspection certificates from local authorities having jurisdiction shall be delivered to the OWNER before final payment.

2. Products

  2.1 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

  2.2 Manufacturing Standards
   
   A. Materials shall be new and approved and labeled by the UL wherever standards have been established by that agency. Defective equipment or equipment damaged in the course of installation or testing shall be replaced or repaired in a manner meeting the approval of the OWNER. Materials to be furnished under this specification shall be the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer’s latest standard design. All items of the same type and rating shall be identical.

   B. Provide electrical equipment rated to withstand available fault current shown on the Contract Drawings.

   C. The CONTRACTOR shall be responsible for verifying the available fault current with the electrical power company prior to submittal of electrical shop drawings.

  2.3 Trade Names and Criteria and Substitutions
   
   A. Manufacturers’ names and catalog numbers indicated on the Contract Drawings are not intended to be proprietary designations. They are used for convenience and indicate general type and quality of materials and equipment required. Equipment and materials by other manufacturers, which in the opinion of the OWNER are of equal quality and which will produce the same result with regard to both their ability to perform the required technical functions as well as to their appearance in the specific location on this project, will be considered.

   B. Wherever detailed operating features or a definite make and size of apparatus are specified, for which such quantities are readily determinable, the make and size of apparatus, which is proposed for use, must conform substantially to the equipment
specified. The same shall apply to important dimensions of the apparatus in relation to the rest of the system to properly fit it into the available space proposed by the CONTRACTOR. Any additional costs whatsoever that result from any approved substitution shall be the responsibility of the CONTRACTOR.

2.4 Hazardous Areas

A. Equipment, materials and installation in hazardous (classified) areas shall comply with NEC Articles 500, 501, 502 and 503.

3. Execution

3.1 Review the electrical underground system and the civil yard piping. Install the electrical underground system in a manner that avoids conflicts with manholes, catch basins, etc. provided under other Divisions of the specifications.

3.2 Sequencing and Scheduling

A. Coordinate electrical equipment installation with other trades.

B. Arrange for chases, slots and openings in the building structures during the progress of construction to allow for the electrical installation.

C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate and integrate the installation of electrical materials and equipment for efficient flow of the work. Coordinate the installation of large equipment requiring position prior to closing in the building.

E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.3 Schedule of Work

A. The schedule of the electrical work shall be arranged to suit the progress of the overall work.

3.4 Demolition

A. Survey the existing electrical systems and equipment identified for removal with representatives from the other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

B. Where a piece of equipment is to be removed all associated ancillary components (e.g., solenoid valves, pressure switches, etc) and associated wiring and conduit shall also be removed.

C. Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal system.
D. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.

E. Unless otherwise specifically noted, remove unused exposed conduit and support systems back to point of concealment including abandoned conduit above accessible ceiling finishes. Remove unused wiring back to source (or nearest point of usage).

F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned or being removed. Provide blank covers for abandoned outlets which are not removed.

G. Disconnect and remove abandoned panelboards, disconnect switches, control stations, distribution equipment, etc.

H. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.

I. Cutting and patching shall be done in an approved manner. Cutting shall not endanger structural integrity or function of the building. Patching shall exactly match contiguous work. Costs of such cutting and patching shall be the responsibility of the CONTRACTOR. Cutting shall be carefully done and damage to the building, piping, wiring or equipment, as a result of cutting, shall be repaired by skilled mechanics of trade involved. Cutting of masonry block and brick shall be done with masonry saw.

J. Repair adjacent construction and finishes damaged during demolition and extension work.

K. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.

L. Coordinate electrical power outages to the electrical systems and equipment with the OWNER. Where duration of proposed outage cannot be allowed by the OWNER, phase the retrofit work to allow the system or equipment to be re-connected to the electrical power system within the time frame allowed by the OWNER or provide temporary power connections as required to maintain service to the systems or equipment. The temporary power can be from a generator or another part of the facility not affected by the outage provided there is sufficient spare capacity.

3.5 Installation

A. Work not installed according to the Contract Drawings and Specification shall be subject to change as directed by the OWNER at CONTRACTOR's expense.

B. Electrical equipment shall be protected against mechanical and water damage. Store all electrical equipment in dry permanent shelters. Do not install electrical equipment in place until structures are weather-tight.

C. Damaged equipment shall be replaced or repaired by the equipment manufacturer, at the OWNER’S discretion and at the CONTRACTOR's expense.
D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted at the CONTRACTOR's expense.

3.6 Labeling of Equipment

A. All motor disconnect switches, motor controllers, motor control center, panelboard, transformer, etc., shall be identified by machine engraved laminated plastic designation plates permanently attached thereto with the name of the equipment it serves. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplate shall be 1 inch by 2.5 inches. Lettering shall be a minimum of 0.25 inches high normal block style. Nameplate designations shall be coordinated with the OWNER.

B. All component parts of each item of equipment or device shall bear the manufacturer's nameplate, giving name of manufacturer, description, size, type, serial and model number and electrical characteristics in order to facilitate maintenance or replacement. The nameplate of a contractor, subcontractor or distributor will not be acceptable.

3.7 Equipment Connection and Standards

A. Disconnect switches and power wiring, up to and including motor connections for all equipment provided under other Sections of this specification, shall be included in this Section unless specifically excluded.

B. No conduit, outlet box, conduit stub-up, controller, etc. shall be installed until exact location has been determined by the coordinated effort of all Subcontractors concerned. Determine electrical requirements of other Sections in order to fully understand wiring, and provide as required for the complete and satisfactory operation of the project. Make connections for other Sections where indicated or required.

C. Obtain approved shop drawings showing wiring diagrams, connection diagrams, roughing-in and hook-up details, for all equipment and comply therewith.

END OF SECTION
Section 16050 – Basic Electrical Materials and Methods

1. General.

1.1 Summary

A. This section addresses certain sections regarding "Site Construction," and "Mechanical" that involve electrical power or control wiring and components, such as push-buttons, junction boxes, or disconnect switches. This section also applies to all sections related to “Electrical” work of this project specification unless specified otherwise in the individual sections.

B. Related sections

- 01600 Materials and Equipment
- 09900 Painting
- 15100 Vertical Extended Shaft Centrifugal Pumping Equipment
- 15150 Non-Clog Submersible Centrifugal Pumps and Drives
- 15163 Variable Frequency Drives
- 15170 Level, Pressure, and Intrusion Sensing Systems
- 15700 Heating and Ventilation Equipment
- 16010 Electrical General Requirements
- 16120 Conductors and Cables
- 16130 Raceways, Boxes, and Fittings
- 16140 Wiring Devices
- 16170 Disconnect Switches
- 16260 Motor Controllers
- 16310 Motor Control Panel
- 16320 Panelboards
- 16330 Transformers
- 16340 Surge Protection Devices
- 16400 Electrical Service
- 16430 Enclosed Main Circuit Breaker
- 16450 Electrical Grounding System
- 16500 Lighting
- 16620 Engine Generators
- 16630 Automatic Load Transfer Switch

C. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

D. The technical paragraphs referred to herein are those paragraphs in Part 2 - Products and Part 3 - Execution of the technical sections that describe products, systems, installation procedures, equipment, and test methods

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 –Materials and Equipment.
B. Manufacturer’s Catalog Data

1) Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data will result in the rejection of the submittal. Submittals shall be project-specific and to highlight the equipment or component to be installed and crossout any information that does not pertain to the project. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for certificates of compliance.

2) Drawings

(a) Submit drawings a minimum of 8 1/2 by 11 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

3) Instructions

(a) Installation procedures or part of the installation procedures are required to be in accordance with manufacturer's instructions, submit printed copies of those instructions prior to installation. Installation of the item shall not proceed until manufacturer's instructions are received. Failure to submit manufacturer's instructions shall be cause for rejection of the equipment or material.

4) Certificates

(a) Submit manufacturer's certifications as required for products, materials, finishes, and equipment as specified in the technical sections. Certificates from material suppliers are not acceptable. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance.
5) Reference Standard Compliance

(a) Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories Inc. (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

6) Independent Testing Organization Certificate

(a) In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the OWNER. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.


2) Association of Edison Illuminating Companies (AEIC)

3) ASTM - American Society for Testing and Materials

(a) ASTM D709 - Standard Specification for Laminated Thermosetting Materials

4) Code of Federal Regulations (CFR)

(a) 29 CFR 1910.147 – The Control of Hazardous Energy (Lockout/Tagout)

5) Institute of Electrical and Electronics Engineers, Inc. (IEEE)

(a) IEEE 100 - The IEEE Standard Dictionary of Electrical and Electronics Terms

6) National Electrical Manufacturers Association (NEMA)

(a) NEMA ICS 6 - Industrial Control and Systems: Enclosures

(b) NEMA MG 1 - Motors and Generators

(c) NEMA MG 10 - Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
1.4 Definitions

A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the Contract Drawings, shall be as defined in IEEE 100.

1.5 Quality Assurance

A. Material and Equipment Qualifications

1) Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products, which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

B. Regulatory Requirements

1) Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70.

C. Alternative Qualifications

1) Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6,000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

D. Service Support

1) The equipment items shall be supported by service organizations, which are located within 50 miles to the equipment installation, in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
E. Modification of References

1) In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the City of Virginia Beach, Department of Public Utilities.

1.6 Posted Operating Instructions

A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

1) Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

2) Start up, proper adjustment, operating, lubrication, and shutdown procedures.

3) Safety Precautions

   (a) The procedure in the event of equipment failure.

   (b) Other items of instruction as recommended by the manufacturer of each system or item of equipment.

4) Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.7 Electrical Requirements

A. Electrical installations shall conform to ANSI C2, NFPA 70, and requirements specified herein.

B. Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, including power and control wiring and conduit in accordance with Section 16120 and 16130.

C. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for lighting, receptacles, field-installed equipment, motor control equipment, motor control center assemblies, etc. Power and control wiring and conduit shall be provided in accordance with Section 16120 and 16130.

D. Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components as shown or specified.
E. Provide controllers for three-phase motors with electronic phase-voltage monitors designed to protect motors from phase-loss, under voltage, and overvoltage of any phase. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.8 Instruction to OWNER’S Maintenance Personnel

A. Where specified in the technical sections, furnish the services of competent instructors to give full instruction to the OWNER’S designated personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

1.9 Lockout Requirements

A. Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with drawing, specification and Code requirements.

2. Products. (Not Used)

3. Execution.

3.1 Hazardous (Classified) Areas

A. Equipment, materials and installation in hazardous (classified) areas shall comply with NEC Articles 500, 501, 502 and 503.

B. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.

C. All conduits routed to hazardous (classified) areas shall use explosion proof seal-offs and be plugged with sealant to prevent the gasses from the wet well from entering the first pull/junction box located in the station. These seal-offs shall be located in the station with easy access; they are not to be located in the wet well.

3.2 Painting of Equipment

A. Factory Applied

1) Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test and the additional requirements specified in the technical specification sections.

B. Field Applied

1) Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09900.
3.3 Mounting of Equipment

A. Equipment shall be arranged and mounted such that height of equipment displays and controls do not exceed 6’-7” above the floor.

END OF SECTION
Section 16120 – Conductors and Cables

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for providing, furnishing and installing a complete system of conductors as indicated or necessary to accomplish the required connections. All conductors shall be installed in a neat and workmanlike manner, with care being taken that conductors are not kinked, scarred, or damaged during installation.

B. **Related sections**

- 01600 Materials and Equipment
- 16010 Electrical General Requirements
- 16050 Basic Electrical Materials and Methods
- 16130 Raceways, Boxes, and Fittings
- 16140 Wiring Devices
- 16450 Electrical Grounding System

1.2 **Submittals**

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 –Materials and Equipment.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. Insulated Cable Engineers Association, Inc. (ICEA)

F. National Electrical Code (NEC)

G. National Electrical Manufacturers Association (NEMA)

H. InterNational Electrical Testing Association (NETA)

I. National Fire Protection Association (NFPA)

J. Underwriters Laboratories (UL)
2. **Products.**

2.1 **Conductors and Insulation**

A. Wire and cable shall be soft drawn, annealed, 98 percent conductivity copper with 600-volt insulation. Aluminum wire will not be accepted.

B. Conductor insulation shall be type THHN/THWN or XHHW.

1) Wire for lighting, receptacles, and other circuits not exceeding 150 Volts to ground shall be NEC type THHN/THWN.

2) Wire for circuits over 150 Volts to ground shall be NEC type XHHW-2.

C. The voltage drop at the end of any circuit shall not exceed 3% of the normal line voltage under full load.

D. Minimum wire size for branch circuits shall be #12 AWG, pilot and control circuits shall not be smaller than #14 AWG.

E. Analog signal wire shall be #16 AWG twisted shielded pairs with a continuous aluminum/polyester foil shield providing 100% coverage. Provide a drain wire in each cable.

2.2 **Color Coding**

A. All branch circuit, feeder and control wiring shall be color coded in accordance with NEC. Color shall be integral with sheath for sizes #12 through #8. Provide minimum 1/2-inch wide color-coded plastic tape strips for conductor size #6 and larger. Strips shall be placed minimum 6 inches on center in all panelboards, junction boxes, pull boxes, conduit fittings, disconnect switches and anywhere the conductors are accessible and visible. Phase sequencing shall be maintained in all panels, disconnects, etc. Sequence shall be (viewing the front of the device) A on left, B center, and C on right. Wire shall be color-coded as noted below. All other conductors shall be of other colors.

1) Color schedule shall be as follows:

<table>
<thead>
<tr>
<th>480Y/277 volt system</th>
<th>208Y/120 volt system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Phase A</td>
</tr>
<tr>
<td>Brown</td>
<td>Black</td>
</tr>
<tr>
<td>Phase B</td>
<td>Phase B</td>
</tr>
<tr>
<td>Orange</td>
<td>Red</td>
</tr>
<tr>
<td>Phase C</td>
<td>Phase C</td>
</tr>
<tr>
<td>Yellow</td>
<td>Blue</td>
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<tr>
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<td>Green</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>120/240 volt, single phase system</th>
<th>120/240 volt, three phase system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Phase A</td>
</tr>
<tr>
<td>Black</td>
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<td>Red</td>
<td>Orange</td>
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<tr>
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<td>Phase C</td>
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<td>Blue</td>
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<td>Ground</td>
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<td>Green</td>
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<td>Ground</td>
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<td>Green</td>
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</tbody>
</table>
2.3 Wire and Cable Markers

A. Wire and cable markers shall be marked with pre-printed, self-adhesive vinyl tapes. Write-on labels shall not be acceptable.

2.4 Joints and Terminations

A. Leave at least 6 inches of free conductor in each outlet or junction-box for making up joints and making connections to fixtures, devices or equipment.

B. For conductors #12 and #10 all fixture and branch circuit joints in junction and outlet boxes shall be made with UL listed pressure type connectors rated at 600 volts and 105 degrees C. Connector body shall consist of a cone-shaped, expandable, square-edged, coil-spring insert, insulated with a color-coded, self-extinguishing nylon shell with two wings placed opposite each other to serve as a built-in wrench. Shell shall be molded of one piece. Wire #8 and larger shall be joined or terminated with solderless pressure connectors properly taped in layers to form a moisture-tight joint.

3. Execution

3.1 Conductor Installation

A. Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes. Junction boxes shall be provided where required. Home runs may be combined in one conduit, provided all connections are in accordance with NEC requirements and the maximum unbalanced current in the neutral does not exceed the capacity of the conductor. All parallel feeder runs shall be laid out and cut to exact same lengths before pulling into conduits to insure load balance. No additional trimming of parallel conductors will be accepted. Conductors shall be pulled by hand and without aid of block and tackle or other mechanical device. Only approved pulling compounds, which will in no way damage the insulation on the conductors or hasten its aging, may be used to facilitate pulling of wire into conduit. Circuiting shown shall be followed unless specific changes are approved by the OWNER.

B. Balance circuits across phase wires of the branch and distribution panels.

C. Switches shall not be connected to the neutral conductor.

D. Where several feeders pass through a common pull box or junction box, the feeders shall be tagged to indicate clearly their electrical characteristics, circuit number, and panel designation. Provide a nameplate, in accordance with Section 16010, with the same information on the cover of the box.

E. Field Testing

1) Test all 600 Volt wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 Volts DC. Test duration shall be one minute. Submit a written test report of results to the OWNER. Notify the OWNER in writing 48 hours prior to testing.
2) Field testing and commissioning shall be done in accordance with latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the International Electrical Testing Association (NETA Standard ATS-1999) unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.

END OF SECTION
Section 16130 – Raceways, Boxes, and Fittings

1. **General.**

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing, installing and providing raceways and fittings for all power systems including low voltage and sensor systems. Provide each outlet in the raceway system with an outlet box to suit the conditions encountered. Each box shall have sufficient volume to accommodate the number of conductors entering the box, in accordance with the requirements of the NEC.

B. Related sections

01600 Materials and Equipment
09900 Painting
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16120 Conductors and Cables

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

1) ANSI C80 – 0.1 Standard for Electrical Rigid Steel Conduit

2) ANSI C80 – 0.5 Standard for Electrical Rigid Metal Conduit - Aluminum

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. National Electrical Code (NEC)

F. National Electrical Manufacturers Association (NEMA)

1) TC-2 – Electrical Polyvinyl Chloride (PVC) Conduit

G. International Electrical Testing Association (NETA)

H. National Fire Protection Association (NFPA)
I. Underwriters Laboratories (UL)

1) UL-6 – Electrical Rigid Metal Conduit – Steel

2) UL-651 – Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

2. Products.

2.1 Raceways

A. Rigid steel conduit shall be mild steel piping, hot-dipped (zinc-coated or sherardized) after threading, of sufficient weight and toughness to withstand cracking and peeling during bending, and comply with ANSI C80.1 and UL-6. Each piece of rigid conduit to be straight, free from blisters and defects, cut square and taper reamed, furnished in 10-foot lengths and threaded at each end. Couplings shall be supplied at one end and a protective sleeve for the other end. All threads shall be clearly cut. Each length of conduit shall bear UL label.

B. Rigid aluminum conduit shall be 6063-T1 aluminum alloy and shall comply with ANSI C80.5.

C. PVC coated rigid steel conduit shall have a permanent plastic coating, factory applied to a minimum thickness of 40 mils coating permanently bonded to it and a chemically cured urethane internal coating. The rigid steel conduit shall comply with ANSI C80.1 and UL-6 prior to coating.

D. PVC conduit shall be Schedule 80, suitable for installation underground, in a concrete ductbank, or embedded in a concrete floor slab. Rigid PVC conduit shall comply with NEMA TC 2 and UL-651 and shall be sunlight resistant, rated for use with 90-degree C conductors. Convert PVC to rigid steel or PVC coated rigid steel before rising out of slab or grade.

E. Flexible metal conduit shall be hot-dipped galvanized, continuous spiral, single strip type and shall be used in accordance with the NEC. In areas subject to moisture, or where indicated, liquid-tight flexible conduit shall be used in accordance with the NEC. Liquid-tight flexible metal conduit shall be square locked, galvanized steel flexible conduit with a moisture-proof, flame-resistant, polyvinyl chloride jacket, for use with rigid metal conduit systems. Fittings shall be standard UL approved with ground connector. Watertight connectors shall be used with liquid-tight flexible conduit.

F. Minimum size conduit shall be 3/4" unless specifically noted to the contrary with larger sizes as required by NEC for number of wires contained therein.

2.2 Fittings

A. All conduit entering or leaving outlet, junction or pull boxes, and cabinets shall have bushings. Provide insulating bushings where required by NEC.
B. Conduit stubs shall have insulating bushings.

C. Provide combination expansion-deflection fittings with bonding jumpers where conduits cross expansion joints or provide other suitable means to compensate for building expansion and contraction.

D. Fittings for RS shall be threaded type. Set screw type fittings for RS, will not be permitted.

E. Cast fittings shall be made of rust resistant alloys of iron, steel or nonferrous materials. Each cast fitting shall be provided with heavy threaded hubs to fit the conduit used.

F. Iron fittings shall be cast, malleable iron thoroughly coated with metallic zinc or cadmium, inside and outside, after all machine work is completed.

G. Cast fitting shall be used on all exposed conduit runs except at impractical locations where factory ells may be used.

H. All cast fittings for PVC coated conduit shall be PVC coated.

I. Fittings for use with aluminum conduit shall be copper free aluminum.

2.3 Outlet Boxes, Junction Boxes, Cabinets, Etc.

A. Switches, devices, etc., requiring outlet boxes shall have steel outlet boxes constructed as required by NEC and installed as indicated. Outlet boxes shall be applied in accordance with the NEC.

B. Outlet boxes shall be pressed steel, one-piece, electro-galvanized or cadmium plated with clean cut, easily removable knockouts. Except as noted hereinafter, minimum size outlet box shall be 4" square, 1-1/2" deep, and shall be increased in dimension to accommodate conductors and devices as required by NEC. Shallower boxes may be used where required by structural conditions and when specifically approved by the OWNER.

C. Where required by NEC or as otherwise indicated, outlet boxes shall be cast iron alloy with threaded conduit hubs.

D. Junction or pull boxes, not over 100 cubic inches in volume, shall be standard outlet boxes. Junction boxes, over 100 cubic inches in volume, shall be constructed of code gauge, galvanized sheet steel in accordance with the requirements of the NEC. Junction boxes shall have removable covers and shall be accessible after completion of work.

E. Cabinets/Boxes (Enclosures)

1) Electrical cabinets shall be the NEMA Types as follows unless otherwise noted on the Contract Drawings:

   (a) NEMA 12 in the Control Room
(b) NEMA 4X in outdoor locations and the valve vault.

(c) NEMA 7 in the wet well.

(d) NEMA 7 (gasketed) in hazardous classified outdoor locations. Provide enclosures labeled for such use.

2) Cabinets shall conform to the requirements of UL and the NEC. Cabinets shall be constructed with interior dimensions not less than those indicated on the Contract Drawings, arranged for flush or surface mounting as indicated. Removable trim shall be provided with a continuous piano-type hinged door and flush 3-point latch and lock. Locks shall be keyed same as panel boards.

F. Provide wall brackets, trapeze, strap hangers, pipe straps and structural supporting units complete with hangers, connectors, bolts, clamps and accessories as required to support raceways, fittings, boxes, and equipment.

G. Each outlet box shall be sized in accordance with the latest effective edition of the NEC.

H. All outlet boxes shall have mounting lugs or ears for mounting wiring devices and covers. Each outlet box shall be equipped with an appropriate cover.

I. An outlet box for a light outlet shall be provided with fixture studs of a size suitable for weight of the light fixture to be supported; but, the light fixture shall not depend on the stud for support. In no case shall the stud be less than 3/8". The stud shall be an integral construction with the box of the type which is inserted from back of the box.

J. Exposed (surface mounted) outlet boxes shall be cast type of same construction as cast fittings described above. Boxes in wet locations shall be gasketed. Boxes used in PVC coated conduit systems shall be PVC coated. Boxes used in aluminum conduit system shall be copper free cast aluminum.

2.4 Hardware

A. Conduit Mounting Equipment:

1) In control room, hangers, rods, backplates, beam clamps, channel, etc. shall be galvanized iron or steel. Conduit mounting equipment in control room, and dry wells shall be stainless steel.

2) Stainless steel hardware shall be used in the valve vault, wet wells, and outdoor locations.

3) Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be galvanized zinc plated steel except that stainless steel shall be used in the valve vault, wet well, and outdoor locations.
B. Conduit Identification Plates:

1) Conduit identification plates shall be embossed stainless steel with stainless steel band, permanently secured to the conduit without screws.

C. Wall and Floor Slab Opening Seals:

1) Wall and floor slab openings shall be sealed with a UL approved expanding material which equals or exceeds the fire rating of the wall or floor construction.

D. Cold Galvanizing Compound:

1) Cold galvanizing compound shall be an approved electrically conductive, corrosion-resistant compound.

E. Conduit Supports:

1) Trapezes:
   
   (a) In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be galvanized steel. Conduit supports in dry wells shall be stainless steel.

   (b) PVC coated steel beams, channels, struts or stainless steel beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in wet, damp, or corrosive and in outdoor locations.

2) Flush Mounted Supports:

   (a) In dry indoor areas, channels, struts, accessories and components shall be galvanized steel. Flush mounted supports in dry wells shall be stainless steel.

   (b) PVC coated steel channels, struts or stainless steel channels, struts with stainless, accessories and components shall be used in wet, damp, or corrosive areas and in outdoor locations.

3) Conduit Racks:

   (a) In dry indoor areas, conduit racks, accessories and components shall be galvanized steel. Conduit racks in dry wells shall be stainless steel.

   (b) PVC coated steel conduit racks or stainless steel conduit racks with stainless, accessories and components shall be shall be used in wet, damp, or corrosive areas and in outdoor locations.

4) Conduit Hangers:

   (a) In dry indoor areas, conduit clamps, rods, beam clamps, bracing, accessories and components shall be galvanized steel. Conduit hangers in dry wells shall be stainless steel.
(b) Stainless steel conduit clamps, rods, beam clamps, bracing, accessories and components shall be used in wet, damp, or corrosive areas and in outdoor locations.

3. Execution.

3.1 Raceway and Fitting Installation

A. Connectors, couplings, fittings and ancillary materials shall be supplied by the conduit manufacturer.

B. Except where otherwise specified, all wiring within structures shall be in rigid steel conduit.

C. PVC conduit shall be used for direct buried applications and concrete encased underground duct banks, except rigid steel conduit shall be used as raceway for shielded process instrumentation wiring, shielded control wiring, and I/O wiring.

D. PVC coated rigid steel conduit shall be used in corrosive areas.

E. PVC coated rigid steel conduit shall be used as a transition section where underground conduit stubs up above ground. The PVC coated rigid steel conduit shall extend a minimum of 6-inches above ground to allow for proper threading of the conduit.

F. Exposed conduits shall be supported per NEC. Run exposed conduit parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceiling. Changes in direction of runs shall be made with symmetrical bends or cast metal fittings. Avoid field made bends and offsets where possible; but, where necessary they shall be made with an approved hickey or conduit bending machine. No bend shall have less than 3-1/2" radius. No bend shall be more than 90 degrees. There shall not be more than four right angle bends or the equivalent in one run. Conduit shall have clean, sharp threads, carefully reamed ends and tight joints. Crushed or deformed conduit shall not be installed. Avoid trapped conduits where possible. Taken care to prevent the lodgment of dirt or trash in conduit, boxes, fittings and equipment during the course of construction. Clogged conduits shall be entirely cleared of obstructions or shall be replaced. Blasting caps or other explosive devices shall not be used to clear obstructions. Fasten conduit to all sheet metal boxes and cabinets with two locknuts where required by NEC, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing will be acceptable.

G. Support conduit by pipe straps, wall brackets, strap hangers, or ceiling trapeze, fastened by toggle bolts on hollow masonry units and bolts and expansion shields on concrete or brick. Unless otherwise indicated, nail type nylon anchors provided with lock washers and nuts or threaded steel studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields or machine screws. Wires twisted around structural members as a support for conduits will not be acceptable. Wooden plugs inserted in concrete or masonry are not acceptable as a base for conduit fastening. Conduit and pipe straps shall not be
welded to steel structures.

3.2 Outlet Box, Junction Box, and Cabinet Installation

A. Install outlet and junction boxes in a rigid and satisfactory manner and support by bar hangers in frame construction. Fasten directly with bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded, threaded studs on steel work. Unless otherwise indicated, nail-type nylon anchors provided with lock washers and nuts or threaded steel studs driven in by powder charge and provided with lock washer and nuts will be acceptable in lieu of expansion shield, or machine screws.

END OF SECTION
Section 16140 – Wiring Devices

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing wiring devices complete with wall plates.

B. Related sections

01600 Materials and Equipment
01650 Starting of System
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16120 Conductors and Cables
16130 Raceways, Boxes, and Fittings

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)
C. American Society for Testing and Materials (ASTM)
D. Institute of Electrical and Electronics Engineers (IEEE)
E. National Electrical Code (NEC)
F. National Electrical Manufacturers Association (NEMA)
G. InterNational Electrical Testing Association (NETA)
H. National Fire Protection Association (NFPA)
I. Underwriters Laboratories (UL)

2. Products.

2.1 Wiring Devices

A. All wiring devices provided for the project shall be by the same manufacturer and shall be specified grade.
B. Local switches shall be single pole, three way, or four way as shown on the Contract Drawings, with black plastic cup, red plastic cover and brown plastic handle. Switches shall be back or side wired, 20 ampere, 120-277 volt. Switches shall be suitable for the area in which they are installed, such as wet, corrosive, dry, hazardous, etc.

C. Duplex convenience receptacles shall be brown plastic, 20 ampere, 125 volt, 2- pole, 3-wire, NEMA, grounded type, and UL listed. Provide weatherproof/corrosion resistant receptacle with cover suitable for the area in which it is installed.

D. Ground fault circuit interrupting receptacles shall conform to NEC, shall be UL listed, shall have a “push-to-test” and “reset” buttons and visible indication of a tripped condition. They shall detect a current imbalance in device or equipment plugged-in of approximately 5 milliamperes and trip out under that condition.

E. Special devices shall be as shown on Contract Drawings.

F. Device plates on unfinished walls and on fittings shall be zinc-coated sheet steel having rounded or beveled edges. Plates shall be one piece to suit device or devices covered. Sectional plates will not be permitted.

3. Execution

3.1 Installation

A. Devices shall be installed in a rigid manner in outlet boxes. Plates shall be installed vertically and with an alignment tolerance of 1/16-inch.

B. Switch and receptacle outlets shall be installed flush with the finished wall surfaces in dry areas with cement block construction, or when raceways are shown as concealed on the Contract Drawings.

C. Do not install flush mounted devices in damp, wet, or corrosive areas. Provide surface-mounted devices in these areas.

END OF SECTION
Section 16170 – Disconnect Switches

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing work related to disconnect switches.

B. Related sections

01600 Materials and Equipment
01650 Starting of System
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. National Electrical Code (NEC)

F. National Electrical Manufacturers Association (NEMA)

G. InterNational Electrical Testing Association (NETA)

H. National Fire Protection Association (NFPA)

I. Underwriters Laboratories (UL)

2. Products.

2.1 Switches

A. Disconnect switches shall be 600 volts rated with the number of poles and a current rating as indicated on the Contract Drawings. Switches shall be fused type where required by equipment manufacturer and as indicated. Switches shall conform to applicable NEMA standards. Switches shall be NEMA type HD, quick-make, quick-
break, visible knife-blade, with full cover interlock, interlock defeat, and flange-mounted operating handle. All current carrying parts shall be copper.

B. Switches shall be horsepower rated when used for motor disconnect means and shall be provided as required by NEC whether indicated or not.

C. All fused switches shall be rejection type, 600 Volts, 200kAIC, provided with time delay, dual element type fuses and shall have horsepower ratings based on the use of this type of fuse.

D. Enclosure Types

1) Disconnect switches shall be NEMA Types as follows unless otherwise shown on the Drawings:

   (a) NEMA 12 in the Control Room.

   (b) NEMA 4X for outdoor locations and the valve vault.

   (c) NEMA 7 in the wet well.

   (d) NEMA 7 (gasketed) in hazardous classified outdoor locations. Provide enclosures labeled for such use.

3. Execution.

   3.1 Mounting

   A. Provide miscellaneous accessories for mounting disconnect switches, including steel angles.

END OF SECTION
1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing component materials and functionality of the equipment that starts and stops the motors that drive the sewage pumps in response to signals from the wet well level sensing system.

B. **Related Sections**

- 01600 Materials and Equipment
- 01650 Starting of System
- 13329 Sequence of Operation
- 15100 Vertical Extended Shaft Centrifugal Pumping Equipment
- 15150 Non-Clog Submersible Centrifugal Pumps and Drives
- 15163 Variable Frequency Drives
- 15170 Level, Pressure, and Intrusion Sensing Systems
- 16010 Electrical General Requirements
- 16050 Basic Electrical Materials and Methods
- 16310 Motor Control Panel

1.2 **Submittals**

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Operations and Maintenance Manual in accordance with Section 01600.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. Insulated Cable Engineers Association, Inc. (ICEA)

F. National Electrical Code (NEC)

G. National Electrical Manufacturers Association (NEMA)

H. InterNational Electrical Testing Association (NETA)
I. National Fire Protection Association (NFPA)

J. Standard for Electrical Safety in the Workplace (NFPA 70E)

K. Underwriters Laboratories (UL)

2. Products

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Motors and Controllers

A. Motors and Controllers shall conform to the latest applicable standards of the NEMA and ANSI for type and class as specifically applied.

2.3 Enclosure

A. NEMA Type 12 enclosure with filtered ventilation, unless otherwise shown on the Contract Drawings.

B. Enclosure shall be labeled to meet UL-508A, shall be listed as a complete assembly, and shall have a Manufacturer’s label indicating short circuit current rating.

2.4 Motor Controllers

A. Across-the-line Type

1) Across-the-line magnetic type motor starters shall be a combination motor circuit protector and contactor, rated in accordance with NEMA standards, magnetically operated, full voltage non-reversing unless otherwise shown on the Contract Drawings, and sized for the pump motor horsepower ratings. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnet motor starters. Motor circuit protectors shall be current limiting type. Combination motor starters shall be fully rated for 65,000 Amps RMS symmetrical. Each pump motor starter shall be furnished with push-to-test pilot lights, hand-off-automatic switch and remote lockout pushbuttons.

2) A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.

3) Each motor starter shall be furnished with an overload relay. Provide a heater element in each phase of the relay, sized for the motor nameplate full load amps. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Auxiliary contacts from the starter shall be wired to the programmable controller for status and alarm monitoring.
4) Provide an external overload reset button for each motor starter.

B. Reduced Voltage Solid-State (RVSS) Type

1) Reduced voltage solid-state type motor starters shall be sized according to NEC Article 430. Each motor starter shall be furnished with six SCRs, full wave type with adjustable current limit and voltage ramp to control starting torque, automatic load sensing circuit to minimize energy consumption, an isolation contactor, and a NEMA overload relay. Provide line side metal oxide varistors on each solid-state starter for transient protection. Motor starters shall be installed in accordance with the manufacturer’s published installation guidelines.

2) The motor starters shall be furnished with a converter module and fanning strip. These two components shall allow the starter to make direct CT readings, which are accurate from either the normal or generator power source. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm. Auxiliary contacts from the solid state starter shall be wired to the programmable controller for status and alarm monitoring.

3) Motors rated 20HP and larger shall be provided with RVSS motor starter. Variable speed motors rated 20HP and larger with a bypass shall be provided with an RVSS motor starter.

4) The motor starters shall open all three phases when motor is de-energized.

C. Provide an external reset button for each motor starter.

2.5 Thermal Overload Protection

A. Each Motor shall be provided with properly sized thermal overload protection, either integral with the controller. Three phase motors shall have overload trip elements in each phase conductor and shall be protected by a phase monitor, as specified in Section 16310.

2.6 Nameplate Rating

A. Nameplate Rating of motors shall be as follows:

<table>
<thead>
<tr>
<th>Power System Voltage</th>
<th>Motor Nameplate Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 volts, single phase</td>
<td>115 volts</td>
</tr>
<tr>
<td>208 volts, three phase</td>
<td>200 volts</td>
</tr>
<tr>
<td>240 volts, 3 phase</td>
<td>230 volts</td>
</tr>
<tr>
<td>480 volts, three phase</td>
<td>460 volts</td>
</tr>
</tbody>
</table>

B. Motors shall be designed to operate at these nameplate voltages, plus or minus ten percent, without damage or reduction in normal life.
3. **Execution.**

3.1 **Mounting**

A. Mount Motor Controllers securely to wall, or within the motor control panel as indicated on the Contract Drawings with stainless steel anchors specifically designed for such installation. Manufacturer shall provide the diameter of fasteners. Fasteners shall be provided complete with washers, nuts, and miscellaneous hardware.

3.2 **Installation**

A. Repaint any damage to factory applied paint finish using touch-up paint furnished by the control panel manufacturer. The entire panel or section shall be repainted in accordance with the requirements at no additional cost to the OWNER.

B. Work not installed according to the Contract Drawings and this Section shall be subject to change as directed by the OWNER. No extra compensation will be allowed for making these changes.

3.3 **Field Testing**

A. Check mechanical interlocks for proper operation. Make any adjustments as required.

B. Adjust motor circuit protectors and voltage trip devices to their correct settings.

C. Install overload heaters per actual motor nameplate currents. If power factor capacitors are installed between starter and motor, use overload relay heaters based on measured motor current.

D. Adjust motor circuit protectors for actual motor nameplate currents.

E. In the event of an equipment fault, notify the OWNER immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the CONTRACTOR, the OWNER and the controller manufacturer's factory service technician. Repair or replace the equipment as directed by the OWNER prior to placing the equipment back into service.

END OF SECTION
1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing the component materials and functionality of the equipment that starts and stops the motors that drive the sewage pumps in response to signals from the wet well level sensing system.

B. Related Sections

01600 Materials and Equipment
01650 Starting of System
13329 Sequence of Operation
15100 Vertical Extended Shaft Centrifugal Pumping Equipment
15150 Non-Clog Submersible Centrifugal Pumps and Drives
15163 Variable Frequency Drives
15170 Level, Pressure, and Intrusion Sensing Systems
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16260 Motor Controllers
16340 Surge Protection Devices

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Submit Factory Test Reports in accordance with Section 01650.

C. Operations and Maintenance Manual in accordance with Section 01600.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. Insulated Cable Engineers Association, Inc. (ICEA)

F. International Society of Automation (ISA)

G. National Electrical Code (NEC)
H. National Electrical Manufacturers Association (NEMA)
I. International Electrical Testing Association (NETA)
J. National Fire Protection Association (NFPA)
K. Standard for Electrical Safety in the Workplace (NFPA 70E)
L. Underwriters Laboratories (UL)
M. Virginia Department of Environmental Quality (DEQ) Sewage Collection and Treatment Regulations (SCAT)

2. Products

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Enclosure

A. The enclosure may be constructed as one piece or in sections, shall be NEMA 12 in design, wall mounted or of free standing style suitable for pad mounting. It shall be provided with an epoxy powder coat finish, ANSI 61 gray on the outside and white on the inside. Provide each section with a removable 16 gauge steel back panel, painted white.

B. Where the control panel houses pump motor circuit breakers, the enclosure shall be provided with flange-mounted main power disconnect operating handle with mechanical interlocks arranged in a manner that will prevent the opening of any and all enclosure doors when the switch is in the ON position. Each enclosure door shall be provided with a continuous piano-type hinge and 3-point latching mechanism operated by a single handle on the door. Door mounted circuit breaker operating mechanism for control panel’s main breaker, pump breakers, and transformer breakers shall be rated for NEMA 12 enclosure with a standard shaft and 6” handle.

C. Control Panel shall be labeled to meet UL-698A, shall be listed as a complete assembly, and shall have a Manufacturer’s label indicating short circuit current rating.

2.3 Control Panel Components

A. Control panel shall have intrinsically safe barriers on all circuits entering the wet well.

B. The control panel shall include circuit breakers if shown on the Contract Drawings, wet well level sensing system, discharge pressure sensing system, relays, timers, control buttons and switches, meters, indicating lights auxiliary contacts, elapsed
time meter, and terminal boards as specified and required. Motor Control Panels with VFDs shall be provided with surge protective devices. The control panel shall be generally arranged as described herein. Should the physical size of any component vary from that shown on the Contract Drawings, the control panel shall be modified, as required, maintaining the same basic order of components.

C. Wires shall be identified at both ends by pre-printed, heat shrink wire labels and all wire numbers shall appear on shop drawings. No two wires shall have the same number. Handwritten labels are not acceptable. All motor wiring and line wiring in the control panel shall be copper type THHN or THWN. All wiring shall conform with NEMA, Standards, and be completely connected, requiring only connection for service.

D. All equipment in the control panel shall be identified in accordance with Section 16010.

E. Control relays shall be 10 ampere, 600V, multi-pole machine tool type. Each contact shall be housed in a clear plastic enclosure to permit visual contact inspection. Contacts shall be easily convertible from normally open to normally closed and vice versa. Relay magnets shall be of CI design and have a double-wound, molded epoxy magnet coil. Provide relays as required for system operation.

F. Pushbuttons, selector switches and pilot lights on the face of the control panel shall be 30mm diameter, NEMA 12. Pilot lights shall be push-to-test type and have long life LED lamps. Where a pushbutton and a pilot light are associated with one system, e.g. failure-to-pump, a combination pushbutton/pilot light may be used.

G. A six digit, non-resetable elapsed time meter shall be connected to each motor starter.

2.4 Arrangement

A. All components shall be wired and tubed to terminal strips for wiring and quick-connect bulkhead fittings for tubing.

B. The control panel shall house the following:

1) A wet well level sensing system as specified in Section 15170 to sense wet well liquid level and transmit it to the PLC.

2) A pressure sensing system as specified in Section 15170 to sense discharge pressure and transmit it to the PLC.

3) A voltage monitor shall continuously monitor supply side voltage to the control panel. Where control panel does not house main power supply conductors, tap service conductors at automatic transfer switch and fuse supply conductors per manufacturer’s recommendations. The voltage monitor shall provide protection for under voltage, power loss in any phase and voltage unbalance. The monitor shall have separately adjustable pickup and dropout ranges and maximum 6 second time delay of drop out. Activation of the voltage monitor shall disconnect power to the pumps. The voltage monitor shall automatically reset upon restoration of proper voltage. The monitor shall have one set of normally open
contacts with a minimum 3 ampere continuous current rating for remote alarm function.

4) For stations with submersible pumps or dry pit submersible pumps a motor-winding-overheat system for each pump motor, which shall consist of temperature sensors imbedded in the motor windings, and necessary relays, timers, pilot lights and control switches in the control panel. If sensors indicate a high winding temperature, relays in the control panel shall stop the respective motor and cause a pilot light on the face of the control panel to illuminate. The sensors in the winding shall reset, automatically, when temperatures return to normal. However, the motor shall remain shut down and the pilot lights illuminated until the system is reset manually.

5) For stations with submersible pumps or dry pit submersible pumps a submersible pump seal failure shall be provided for each pump. When the relay is tripped, a seal failure light on the control panel shall be illuminated. The respective pump motor shall not be locked out of operation. The seal failure relay shall originally be factory set per the pump manufacturer’s recommendations. The relay shall be reset by the factory within one year of operation to adjust for installed conditions and to minimize nuisance trips.

6) A failure-to-pump alarm, which shall consist of a lever arm type limit switch mounted on the discharge check valve at the pump, and necessary relays, timers, pilot lights and control switches in the control panel. When a pump is called upon to run, a time delay shall be energized to allow enough time for the pump to establish flow. If, after this set time elapses, the check valve limit switch has not detected flow, then the respective failure-to-pump light on the control panel shall be illuminated. A failure-to-pump condition shall not lock out the pump. The failure-to-pump light shall remain illuminated until the system is reset manually.

7) Interposing relays, as required, between PLC outputs and other system components.

8) Four-pole relay to isolate the PLC command outputs and the Murphy Gauge output commands.

9) Lag pump timer, as required, to energize relay when lag pump command is present.

10) Alarm contacts and circuitry wired to a terminal strip for the station output signals. Refer to Section 13329 for list of required alarms.

C. The following components shall be mounted in the door or doors of the control panel with components directly associated with a pump in the door of the section containing control components for that pump and components common to the system and to both the pumps in the door of the system control section or sections:

1) 1 - White “control on” pilot light.

2) 1 - 4.5 inch wet well level gauge.
3) 1- Manual transfer switch to switch between the PLC and wet well level gauge.

4) Run time meters reading in hours and tenths, total of 6 digits, non-resetting type; one for each pump motor.

5) Hand-off-auto switches, one for each pump motor. Provide extra set of contacts in switch to provide means for detection of pumps in “off” or “hand” position. Handle shall be illuminated when switch is in the auto position by long life LED lamp, or separate pilot lights may be provided to indicate this condition.

6) 1 - Selector switch for pump alternating (sequencing) system - automatic- pump #1 lead - pump #2 lead (pump #3 lead if appropriate).

7) Level transducer display for wet well level.

8) Pressure sensor display for pump discharge pressure.

9) Pilot lights, one for each pump, to indicate a failure-to-pump condition.

10) Reset pushbuttons, one for each pump, for reset of the failure-to-pump condition.

11) Pilot lights, one for each pump, to indicate a motor overload trip condition.

12) Reset pushbuttons, one for each pump, for electromagnetic reset of the thermal overload relay.

13) Pilot lights, one for each pump, to indicate operation of motor winding overheat condition.

14) Reset pushbuttons, one for each pump, for reset of motor winding overheat condition.

15) Pilot lights, one for each pump, to indicate pump running condition.

16) Pilot lights, one for each pump, to indicate seal failure condition, for stations with submersible or “dry pit” submersible pumps.

17) Reset pushbuttons, one for each pump, for reset of seal failure condition, for stations with submersible or run dry submersible pumps.

18) 1 - Rotameter (air flow gage) as specified in Section 15170.

19) 1 - Selector switch, for manual selection (power) of the air pumps as specified in Section 15170.

20) 1 – Three-way ball valve for manual selection (air flow) of the air pumps as specified in Section 15170.

D. The following components shall be mounted on the top of the control panel:

1) 2- Air pumps (secured with dampeners to isolate vibration).
2) 1 – Duplex receptacle (flush mounted) for air pumps.

E. The following components shall be mounted on the bottom side of the control panel:

1) 1 – Condensate Trap with drain valve (air/water separator) as specified in Section 15170.

2.5 System Operating Sequence

A. Sequence shall be as described in Section 13329.

3. Execution.

3.1 Installation

A. Provide a complete motor control panel, including equipment and systems as specified herein, all in accordance with NEMA Standards.

B. Supply voltage shall be as indicated on the Contract Drawings.

C. Installation procedures shall be in accordance with the recommendations of the manufacturers of the control panel and its components.

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the control panel manufacturer. The entire panel or section shall be repainted at no additional cost to the OWNER.

E. Work not installed according to the Contract Drawings and this Section shall be subject to change as directed by the OWNER. No extra compensation will be allowed for making these changes.

3.2 Testing

A. The complete control panel shall be subject to a factory test for proper operation.

3.3 Field Test

A. The equipment shall be tested in operation and in the presence of the OWNER and ENGINEER to demonstrate compliance with specification requirements.

B. Check mechanical interlocks for proper operation. Make any adjustments as required.

C. Adjust motor circuit protectors and voltage trip devices to their correct settings.

D. In the event of an equipment fault, notify the OWNER immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the CONTRACTOR, the OWNER and the controller manufacturer's factory service technician. Repair or replace the equipment as directed by the OWNER prior to placing the equipment back into service.
3.4 Manufacturer’s Representative

A. Provide manufacturer’s representative in accordance with Section 01650.

3.5 Maintenance and Operating Instructions

A. The control panel shall be connected, inspected and tested under the supervision of a representative of the manufacturer. The representative shall also instruct the OWNER’S personnel regarding proper operation and maintenance of the equipment.

END OF SECTION
Section 16320 – Panelboards

1. General

1.1 Summary

A. This section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

B. Related Sections

01600 Materials and Equipment
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division 1, General Provisions, and Section 01600 – Materials and Equipment.

B. Product Data: For each type of product.

C. Shop Drawings: For each panelboard and related equipment.

1) Include dimensioned plans with elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2) Detail enclosure types.

3) Detail bus configuration, current, and voltage ratings.

4) Short-circuit current rating of panelboards and overcurrent protective devices.

5) Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

6) Include wiring diagrams for power wiring.

D. Panelboard schedules for installation in panelboards.

E. Operations and Maintenance Manual in accordance with Section 01600.

1.3 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.
1.4 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. National Electrical Code (NEC)

F. National Electrical Safety Code (NESC)

G. National Electrical Manufacturers Association (NEMA)

H. InterNational Electrical Testing Association (NETA)

I. National Fire Protection Association (NFPA)

J. Standard for Electrical Safety in the Workplace (NFPA 70E)

K. Underwriters Laboratories (UL)

2. Products.

2.1 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 General Requirements for Panelboards

A. Enclosures: Surface-mounted cabinets

   1) NEMA 250, Type 3R (non-ventilated), unless otherwise noted on Contract Drawings.

   2) Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.


B. Incoming Mains Location: Top or bottom.

C. Phase, Neutral, and Ground Buses: Tin-plated aluminum or copper.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
1) Main and Neutral Lugs: Mechanical type.

2) Ground Lugs and Bus Configured Terminators: Mechanical type.

E. Service Equipment Label: NRTL (Nationally Recognized Testing Laboratory) labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.


2.3 Distribution and Lighting and Appliance Branch Circuit Panelboards

A. Panelboards: NEMA PB 1, power and feeder distribution type or lighting and appliance branch circuit type as required.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

C. Main Circuit Breaker: Thermal-magnetic circuit breaker, inverse time-current element and instantaneous magnetic trip element, unless otherwise noted.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

3. Execution.

3.1 Installation

A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim so that the handle on any breaker does not exceed 78”.

C. Mount panelboard cabinet plumb and rigid without distortion of box.

D. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

E. Comply with (National Electrical Contractors Association) NECA 1.

3.2 Identification

A. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Update any existing panelboard directories affected by work under this contract.

3.3 Field Quality Control

A. Perform tests and inspections as follows:

1) Test insulation resistance for each panelboard bus, component, connecting supply, and feeder.
2) Test continuity of each circuit.


4) Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Panelboards will be considered defective if they do not pass tests and inspections.

END OF SECTION
Section 16330 – Transformers

1. **General.**

   1.1 **Summary**

      A. This section addresses all supervision, labor, materials and equipment in the work for furnishing, installing and providing dry-type transformers as shown on the drawings to step the main incoming service voltage down to the utilization voltage required for lighting, small motor and other loads shown.

      B. **Related sections**

         01600 Materials and Equipment
         16010 Electrical General Requirements
         16050 Basic Electrical Materials and Methods

   1.2 **Submittals**

      A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

   1.3 **References**

      A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition

         B. American National Standards Institute (ANSI)
         C. American Society for Testing and Materials (ASTM)
         D. Institute of Electrical and Electronics Engineers (IEEE)
         E. Insulated Cable Engineers Association, Inc. (ICEA)
         F. National Electrical Code (NEC)
         G. National Electrical Manufacturers Association (NEMA)
         H. InterNational Electrical Testing Association (NETA)
         I. National Fire Protection Association (NFPA)
         J. Underwriters Laboratories (UL)

2. **Products.**

   2.1 **Transformers**

      A. Transformers shall conform with the following requirements and shall have 6-2.5
percent primary taps, with four below and two above rated primary voltage, and shall have ratings as indicated on the Contract Drawings.

B. Transformers shall be dry type, two-winding with kVA and voltage ratings as shown on the Contract Drawings. Transformer shall incorporate a 220 degree C insulation system and be designed not to exceed 115 degrees C temperature rise above a 40 degree C ambient full load.

C. Windings shall be copper.

D. Transformers shall be built in accordance with ANSI C89.2, and shall be UL listed.

E. Transformers shall be energy efficient type, meeting the efficiency levels specified in NEMA Standard TP1-2002. Efficiency shall be tested in accordance with TP1-2002.

F. Transformer impedance shall be a minimum of 3 percent and a maximum of 5 percent.

G. Transformers shall be furnished with hot-dipped galvanized mounting hardware. In NEMA 4X areas or where stainless steel enclosures are required, hardware shall be Type 316 stainless steel.

H. Provide ground lug on frame and strap ground core assembly to frame of enclosure.

3. Execution

3.1 Mounting

A. Transformers shall be floor-mounted on a 4-inch housekeeping pad, wall-mounted, or suspended from the ceiling in accordance with the Contract Drawings.

B. Pad-mounted transformers shall be on suitable vibration isolating foundations. Provide clear space around transformer in accordance with manufacturer’s recommendation.

C. Provide short lengths of flexible metallic conduit at all connections thereto to prevent transmission of transformer hum to building structure and to conduit systems.

END OF SECTION
Section 16340 – Surge Protection Devices

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing, installing and providing field-mounted Surge Protection Devices (SPDs) for low-voltage (120V to 600V) power distribution and control equipment.

B. SPDs shall only be provided for Motor Control Panels when variable frequency drives (VFDs) are used to control the motor speed.

C. **Related Sections**

   01600 Materials and Equipment
   16010 Electrical General Requirements
   16050 Basic Electrical Materials and Methods
   16310 Motor Control Panel

1.2 **Submittals**

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division 1, General Provisions, and Section 01600 – Materials and Equipment.

B. **Product Data:** For each type of product.

   1) Manufacturer’s literature and warranty information.

   2) Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

   3) Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Nominal ratings, MCOVs (Maximum Continuous Operating Voltages), type designations, OCPD (OverCurrent Protective Device) requirements, model numbers, system voltages, and modes of protection.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. **American National Standards Institute (ANSI)**

C. **American Society for Testing and Materials (ASTM)**

D. **Institute of Electrical and Electronics Engineers (IEEE)**

E. **National Electrical Code (NEC)**
F. National Electrical Manufacturers Association (NEMA)
G. InterNational Electrical Testing Association (NETA)
H. National Fire Protection Association (NFPA)
I. Underwriters Laboratories (UL)

2. Products.

2.1 Products

A. Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 General SPD Requirements

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.
C. Comply with UL 1449.
D. MCOV of the SPD shall be at least 125 percent of the nominal system voltage.
E. Utilize bolted compression lugs for internal wiring.
F. Modular design with field replaceable modules, one per phase.
G. SPDs shall utilize a high-energy transient suppression circuit that provides 10 modes of suppression, and also provides noise filtration. The device shall be suitable for continuous operation to provide protection for the service entrance.

2.3 Service Entrance Suppressors

A. SPDs: Comply with UL 1449, Type 2.

1) SPDs with the following features and accessories:
   a. Include LED indicator lights for power and protection status.
   b. Form C dry contacts and audible alarm with silencing switch for notification of any failures. Coordinate connection requirements with OWNER’s Standard alarm transmitter.
   c. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   d. Six-digit transient event counter set to totalize surges.
e. Push-to-test diagnostic switches.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

C. Protection modes and UL 1449 VPR (Voltage Protection Rating) for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits or 240/120 V, three-phase, four wire circuits shall not exceed the following:

1) Line to Neutral:
   a. 1200 V for 480Y/277 V
   b. 700 V for 208Y/120 V or 240/120 V

2) Line to Ground:
   a. 1200 V for 480Y/277 V
   b. 700 V for 208Y/120 V or 240/120 V

3) Neutral to Ground:
   a. 1200 V for 480Y/277 V
   b. 700 V for 208Y/120 V or 240/120 V

4) Line to Line:
   a. 2000 V for 480Y/277 V
   b. 1000 V for 208Y/120 V or 240/120 V

D. SCCR (Short Circuit Current Rating): Equal or exceed 200 kA.

E. Nominal Rating: 20 kA.

F. Enclosures: NEMA 250, Type 4X stainless steel, unless otherwise indicated.

2.4 Spare Parts

A. Spare parts shall be packaged individually in boxes that are clearly labeled with the part name and manufacturer’s part/stock number. Provide the following spare parts for the surge protection devices:

1) Three (3) surge protection modules, one per phase.

2) One complete set of 200 kA fuses.
3. **Execution.**

3.1 **Installation**

   A. Comply with (National Electrical Contractors Association) NECA 1.

   B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

   C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

   D. Use crimped connectors and splices only. Wire nuts are unacceptable.

   E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

3.2 **Field Quality Control**

   A. Comply with the manufacturer’s recommendations for installation. Perform the following inspections in the presence of the OWNER.

      1) Compare equipment nameplate data for compliance with the Contract Drawings and Specifications.

      2) Inspect anchorage, alignment, grounding, and clearances.

      3) Verify that electrical wiring installation complies with manufacturer's written installation requirements.

END OF SECTION
Section 16400 – Electric Service

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing complete permanent and temporary electric service including termination, metering, conduit, and all equipment and labor required, as indicated on the Contract Drawings, and specified herein.

B. Related Sections

01600 Materials and Equipment
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Section I, General Provisions, and Section 01600 – Materials and Equipment.

1.3 Coordination with Electric Utility Company

A. Contact the power company for specific instructions regarding service requirements before beginning work. Complete system must meet with power company approval.

B. Coordinate work with the latest edition of Electric Utility service manual.

1.4 Product Delivery, Handling, and Storage

A. Product Handling

1) Deliver all materials in good condition. Store in dry place, off ground, and keep dry at all times.

2. Products.

2.1 Materials

A. Service Conduit

1) Service conduit shall be PVC Schedule 80 conduit, unless otherwise indicated.

B. Current Transformer/Potential Transformer Cabinet and Meter Base:

1) Current transformer/potential transformer cabinet (if required) and meter base shall be as shown on the Contract Drawings, to be furnished by the power company; transported to the project site and installed by CONTRACTOR.
3. **Execution.**

3.1 **Maintenance of Operations**

A. The CONTRACTOR shall be responsible for all coordination efforts with the power company to provide temporary power as required for maintenance of operations of existing pump stations during construction.

B. Coordinate electrical power outages to the electrical systems and equipment with the OWNER. Where duration of proposed outage cannot be allowed by the OWNER, phase the retrofit work to allow the system or equipment to be re-connected to the electrical power system within the time frame allowed by the OWNER or provide temporary power connections as required to maintain service to the systems or equipment.

C. Temporary power can be from a generator or another part of the facility not affected by the outage provided there is sufficient spare capacity. Where temporary power is provided by another part of the facility, coordinate temporary power with Power Company and the City of Virginia Beach Permits and Inspections office.

3.2 **Installation**

A. Service conduit shall be stubbed out 5-feet from building and capped, unless otherwise indicated.

B. Wiring from the power company’s transformer to CT cabinet or meter base will be furnished and installed by the power company, unless otherwise indicated.

C. All primary conductors shall be furnished and installed by the power company.

D. **Secondary Conductors**

1) All secondary conductors shall be furnished and installed by the power company, unless otherwise indicated.

E. **Meter**

1) Install a 1-1/4" conduit from C.T./P.T. to meter location where required. Meter socket will be supplied by the power company; transported to the project site and installed by CONTRACTOR. Meter will be supplied and installed by the power company.

F. **Transformer/Pad**

1) Transformer and pad (if required) will be supplied and installed by the power company. The CONTRACTOR is responsible for site grading to accommodate the transformer pad.

G. **Costs**

1) All power company installation costs for permanent power shall be paid by the
OWNER for Capital Improvement Program (CIP) constructed pump stations.

2) All power company installation costs for permanent power shall be paid by the Developer (in accordance with Public Utilities Administrative Policy) for developer constructed pump stations.

3) All power company costs and associated inspection fees for installation of temporary power for construction shall be paid by the CONTRACTOR.

END OF SECTION
Section 16430 – Enclosed Main Circuit Breaker

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing work related to microprocessor-based trip units for the circuit breakers installed as the main service over current protection device. Trip units shall be 600 volts rated with a current rating as indicated to match the associated circuit breaker. Trip units shall conform to applicable NEMA standards.

B. Related sections

01600 Materials and Equipment
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods

1.2 **Submittals**

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions and Section 01600 – Material and Equipment.

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. National Electrical Code (NEC)

F. National Electrical Manufacturers Association (NEMA)

G. InterNational Electrical Testing Association (NETA)

H. National Fire Protection Association (NFPA)

I. Standard for Electrical Safety in the Workplace (NFPA 70E)

J. Underwriters Laboratories (UL)

2. **Products.**

2.1 Trip Units 800A and Above
A. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.

B. An adjustable trip setting dial mounted on the front of the trip unit, or interchangeable ratings plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

C. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

1) Independently adjustable long-time setting (set by adjusting the trip setting dial or rating plug)

2) Independently adjustable short-time setting and delay with selective curve shaping

3) Independently adjustable instantaneous setting

4) Independently adjustable ground fault setting and delay

D. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

E. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override.

F. Provide neutral ground fault sensor for four-wire loads.

2.2 Trip Units Less Than 800A

A. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.

B. An adjustable trip setting dial mounted on the front of the trip unit, or interchangeable ratings plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
C. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

1) Adjustable long-time setting (set by adjusting the trip setting dial or rating plug)

2) Adjustable short-time setting and delay with selective curve shaping

3) Adjustable instantaneous setting

4) Independently Adjustable ground fault setting and delay

D. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

E. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override.

2.3 Enclosures

A. Enclosed main circuit breaker enclosures shall be as follows:

1) NEMA 12 Type painted stainless steel with gasket for indoor locations.

2) NEMA 4X Type 316 stainless steel for outdoor locations.

3. Execution

3.1 Protective Device Settings

A. The tripping device shall be adjusted to the settings specified in the protective device coordination study prior to energizing the equipment.

B. The equipment shall be tested in accordance with NETA Acceptance Testing. Verify the trip functions for all size units and ground fault settings for units 800A and larger. Perform ground-fault protection performance test per Manufacturer instructions for units 800A and larger. Provide written successful test results.

END OF SECTION
Section 16450 – Electrical Grounding System

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing electrical ground systems in accordance with Article 250 of NEC.

B. Related sections

01600 Materials and Equipment
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods
16120 Conductors and Cables

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Section I, General Provisions, and Section 01600 – Materials and Equipment.

B. Submit ground test results as specified in Section 3.3 to measure the resistance to ground of the grounding system.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

1) American Society for Testing and Materials (ASTM)
2) Institute of Electrical and Electronics Engineers (IEEE)
3) National Electrical Code (NEC)
4) InterNational Electrical Testing Association (NETA)
5) National Fire Protection Association (NFPA)
6) Underwriters Laboratories (UL)

2. Products.

2.1 Ground Conductors

A. Wire between the grounding electrode and other points of the grounding system shall be un-insulated copper with conductor properties as required by the National Electrical Code.
2.2 Ground Rods

A. Ground rods shall be copper-clad steel 3/4-inch minimum diameter and 10-foot minimum length in accordance with UL 467. A minimum of two ground rods are required at least ten feet apart. The ground rods shall have a resistance to ground of no more than 25 ohms.

2.3 Ground Rod Test Wells

A. Ground rod test wells shall be concrete with complete cast iron riser ring and traffic cover marked “GROUND ROD”. Boxes and covers shall be suitable for H-20 wheel loading.

B. Ground rod test well shall be a minimum of 12-inches deep and 12-inches in diameter for round type boxes or 12-inch width by 12-inch length for rectangular boxes.

2.4 Exothermic Weld

A. All cable to ground rod connections shall be accomplished by the exothermic welding process.

B. Furnish all materials and molds necessary to properly perform all required exothermic welds.

C. Connect ground system with copper water service in addition to connection with ground rods. Connection shall be ahead of any interior valves on the waterline.

3. Execution

3.1 General

A. Conduits, panels, metal boxes, cabinets, fixtures, outlets and other metal enclosures surrounding or containing electrical equipment, motors or apparatus with metal frames shall be grounded in accordance with the National Electrical Code.

3.2 Installation

A. The electrical continuity of all metal raceways shall be insured by means of properly installing locknuts, bonding straps or other approved means. Provide a separate green conductor in all circuits installed in both rigid and flexible conduit and bond the conductor to the cabinet, outlet box, etc., at each end of the run. Ground connections shall be made by means of welded or bolted ground clamps or grounding-type bushings.

B. Equipment grounding conductors shall be provided with green colored insulation in all raceways.

C. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized in accordance with NEC Article 250-66.
3.3 Inspection And Testing

A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.

B. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance to ground of the system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

C. All test equipment shall be provided under this Section and approved by the OWNER.

D. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

E. Testing shall be performed before energizing the distribution system.

F. Test all grounded cases and metal parts associated with the electrical equipment for continuity with the ground system.

G. Submit test results to the OWNER for review.

H. Notify the OWNER immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION
Section 16500 – Lighting

1. General.

1.1 Summary

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing lighting. The CONTRACTOR shall provide luminaires as shown on the Contract Drawings.

B. Related Sections

01600 Materials and Equipment
01650 Starting of System
16010 Electrical General Requirements
16050 Basic Electrical Materials and Methods

1.2 Submittals

A. Submit shop drawings and manufacturers data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Shop Drawings

1) Manufacturer's latest publication of each fixture, including construction details, light distribution details and/or coefficients.

1.3 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. American National Standards Institute (ANSI)

1) ANSI-C82.16 - American National Standard for Light-Emitting Diode Drivers—Methods of Measurement

C. American Society for Testing and Materials (ASTM)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. National Electrical Code (NEC)

F. Illuminating Engineering Society of North America (IESNA)

G. National Electrical Manufacturers Association (NEMA)

H. InterNational Electrical Testing Association (NETA)

I. National Fire Protection Association (NFPA)
J. Underwriters Laboratories (UL)

1) UL 1598 – Luminaires

2) UL 8750 – Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products

3) UL 844 Standard for Electric Lighting Fixtures for Use in Hazardous (Classified) Locations

1.4 Quality Assurance

A. Regulations

1) Luminaires shall meet all Federal, State and local required criteria.

2) Luminaires shall be mounted in accordance with manufacturer's recommendations.

3) The luminaires shall be listed by Underwriters Laboratories, Inc. (UL) or by a Nationally Recognized Testing Laboratory (NRTL) and be listed and labeled for the installation location (i.e., dry, wet, damp, hazardous area).

4) The installation shall comply with the National Electrical Code and the National Fire Protection Association.

B. Qualifications

1) Manufacturers: Firms regularly engaged in manufacture of luminaires of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.5 Product Delivery, Handling, and Storage

A. Product Handling

1) Deliver all materials in good condition. Store in dry place, off ground, and keep dry at all times.

1.6 Warranty

A. All luminaires shall have a minimum five (5) year factory warranty for defective or non-starting power supply units (driver), and LED source assemblies, which includes, but not limited to: LED package, LED arrays, LED modules, LED die, encapsulate, and phosphor.

B. All photocells used in exterior applications shall have a minimum ten (10) year factory warranty.
2. Products.

2.1 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 Lighting Fixtures (Luminaires)

A. Luminaires shall be LED and be provided complete with, mounting hardware, accessories, canopies, necessary guards, straps, supports or hangers and other miscellaneous materials and devices to assure satisfactory installation and desired function where installed and shall be approved before installation.

B. Light Emitting Diode (LED) luminaires shall meet the following requirements.

1) Each luminaire shall be complete with prewired integral drivers and optical (LED) assemblies.

2) Luminaires that require remote mounting of any components needed for its operation, such as drivers, or light engine electronics are not permitted. All components needed to make the luminaire operational shall be integral to the fixture housing with exception of security applications.

3) Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire or the distribution type.

4) LED fixtures shall be modular and allow for separate replacement of LED lighting modules, drivers and surge suppressors. User serviceable LED lighting modules and drivers shall be replacement from the room side.

5) Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids.

6) Luminaires has been tested as an integral unit to Illuminating Engineering Society (IES) LM-79 (Electrical and Photometric Measurements of Solid State Lighting Products) and LM-80 (Measuring Lumen Maintenance of LED Light Sources).

7) The rated life and lumen depreciation of the luminaire shall be a minimum of 50,000 hours with a 70% depreciation in lumen output.

8) The color rendition index (CRI) shall be a minimum of 80 and the CCT a minimum of 4000°K, or as noted on the fixture schedule.

9) The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

10) The total harmonic distortion shall not exceed 20 percent at any standard input voltage.

11) Luminaires shall be suitable for 120V or 277V operation and provide a minimum lumen output of 3,000 lumens.
C. LED Power Supply Unit (Drivers)

1) LED drivers shall accept the voltage as indicated on the Contract Drawings.

2) Driver(s) shall be UL8750 class 2 listed for their intended purpose.

3) Individual driver(s) shall be equipped with surge protection (6kV minimum for building mounted units and 10kV minimum for pole mounted units) in accordance with IEEE/ANSI C62.4.1 and shall be rated for a category “C” environment.

4) Driver(s) shall have a minimum efficiency of 85%.

5) Driver(s) shall reliably start at minimum ambient temperatures from -40 deg. C to 40 deg. C with THD of <=20%.

6) Dimmable drivers shall deliver full-range dimming without LED strobing or flicker across their full dimming range.

D. Exterior Wall-Packs

1) Exterior wall-packs shall be full cutoff type with motion sensor.

2) Luminaire shall be suitable for 120V or 277V operation, 12 watts and provide a minimum lumen output of 828 lumens with 5000k color.

3. Execution

3.1 Installation

A. CONTRACTOR shall furnish supports and necessary mounting hardware for luminaires.

B. The luminaire manufacturer's catalog numbers, describing the various types of luminaires, shall be used as a guide only and do not include all the required accessories or hardware that may be required for a complete installation. The CONTRACTOR shall be responsible for furnishing, at no additional cost to the OWNER, all of the required accessories and hardware for a complete installation. The CONTRACTOR shall be responsible for ordering the proper luminaires with hardware for installation in or on the specified surfaces.

C. All inoperable lamps shall be replaced with new lamps, at no additional cost to the OWNER, during the course of construction, up to and including the date of final acceptance of the pump station by the OWNER.

D. Plastic dust cover bags to be provided with new parabolic reflector luminaire shall be removed after all construction activity that may cause dust formation on reflector surfaces has been completed.

E. All luminaire shall be left in a clean condition, free of dirt and defects, before acceptance by the OWNER.
END OF SECTION
1. **General**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing packaged engine-generator sets for standby power and associated accessories as shown on the Contract Drawings.

B. **Related Sections**

- 01600 Materials and Equipment
- 01650 Starting of System
- 15492 Fuel Gas Piping
- 16010 Electrical General Requirements
- 16050 Basic Electrical Materials and Methods
- 16620 Automatic Load Transfer Switch

1.2 **Submittals**

A. **Product Data**: For each type of packaged engine generator and accessory indicated.

B. **Shop Drawings**: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1) **In addition to full descriptive data, dimensional drawings, heights of equipment, and wiring diagrams, the following information shall be furnished for evaluation of all equipment proposed:**

   (a) Name and location of engine-generator supplier's parts and service facilities within a 50-mile radius of the project site. Parts and service shall be available on a 24-hour basis for engine and generator.

   (b) Manufacturer's Published Warranty.

   (c) Manufacturer and Model of Engine.

      (1) Bore, stroke, and number of pistons.

      (2) Engine displacement.

      (3) Piston speed.

      (4) Engine rating at 1800 RPM.

      (5) BMEP.

      (6) Exhaust emissions data.
(d) Alternator Data

(1) Manufacturer

(2) Model

(3) Rated kVA

(4) Rated kW

(5) Voltage

(6) Temperature rise above 40 degrees C ambient

(7) Stator by thermometer (degrees C)

(8) Field by resistance (degrees C)

(9) Class of insulation

(10) Alternator subtransient reactance (Ohms or P.U.)

(e) Radiator Data

(1) Radiator fan cooling air volume (CFM).

(2) Radiator fan power (BHP).

(3) Radiator fan external static pressure (inches water column).

(4) Full load heat rejection to enclosure (BTU/min).

(5) Full load heat rejection to engine coolant (BTU/min).

(f) Exhaust System Data

(1) Combustion air volume (CFM).

(2) Silencer and exhaust piping size.

(3) Silencer data.

(4) Exhaust piping data.

(5) Insulation data.

(g) Fuel System Data

(1) Diesel - Fuel consumption rate at full load, three-quarters load, and half load in cubic feet per hour.
(2) Diesel – Base tank sizing calculations.

(3) Fuel piping and fuel component materials.

(h) Manufacturer of generator make and type of generator, and generator electrical rating. Include generator lock rotor motor starting curve.

(i) Manufacturer and type of voltage regulator.

(j) Manufacturer and model of batteries and battery charger.

(k) Manufacturer and type of governor.

(l) Manufacturer and model of weather protective enclosure. Include sound report with sound attenuation and sound level data.

(1) Details for proposed louvers, including materials and louver performance data – pressure drop versus velocity curve, free area chart, and beginning point of water penetration curve.

(2) Details of the materials and arrangement of the radiator exhaust ductwork, inlet and exhaust dampers, and inlet and exhaust hoods for the enclosure.

(3) Sizing calculations for the enclosure radiator/combustion air intakes and radiator exhaust outlets.

(m) Report of exhaust emissions showing compliance with applicable regulations.

(n) Wiring diagrams, including power, signal, and control cabling.

(o) Certification of conformance to the EPA Emissions Tier Designation as applicable to the engine horsepower rating.

(p) Complete details on the following:

(1) Battery charger

(2) Jacket heater

(3) Enclosure base fuel tank

2) The Manufacturer shall provide computerized calculations substantiating the ability of the submitted generator unit to start and run the station with all loads indicated. Calculations shall utilize the following criteria (exact data will be furnished to the manufacturer at the time of the order):

(a) Maximum voltage dip shall be 30%.
(b) Calculations shall assume one pump plus all other loads (10kw minimum) starting as load step number one, with the addition of the second pump starting as load step number two.

(c) Calculations shall account for the type of motor controllers being utilized. If variable frequency drives are being used, the calculations shall account for the backup type motor controllers being utilized (across-the-line, unless otherwise noted).

C. Factory test reports.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operations and Maintenance Manual in accordance with Section 01600.

1.3 Quality assurance

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

1) The engine-generator set shall be the product of a firm regularly engaged in the manufacture of engines and generator sets and shall meet the requirements set forth herein. The equipment shall be a standard model in regular production at the manufacturer's place of business.

2) The engine-generator supplier shall be the factory-authorized sales and service dealership for the equipment to be supplied. The supplier shall maintain a parts and service facility within 50 miles of the project site, with an inventory of maintenance and repair parts for the equipment to be provided, as well as a staff of trained service technicians. The supplier shall furnish the installing CONTRACTOR all installation and testing supervision necessary for final approval and acceptance of the equipment by the OWNER.

(a) The engine-generator supplier’s local service facility shall stock a minimum of $1,000,000 of maintenance and repair parts. Any parts not stocked in the local service facility shall be available within 24-hours.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
1.4 Project conditions

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1) Ambient Temperature: Minus 15 to plus 40 deg C.

2) Relative Humidity: 0 to 95 percent.

3) Altitude: Sea level to 1000 feet.

1.5 Warranty

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period. This warranty shall cover all after-market items installed by the supplier.

1) Warranty Period: Five years from date of Final Acceptance for engine generator enclosure paint finishes, two years from date of Final acceptance for all other components.

2) All warranty work shall be performed by factory-trained generator technicians. Non-factory trained or non-generator technicians shall not be acceptable.

1.6 References

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

B. Air Movement and Control Association International, Inc. (AMCA)

1) AMCA 511 - Certified Ratings Program - Product Rating Manual for Air Control Devices

C. American National Standards Institute (ANSI)

1) ANSI B16.3 – Malleable Iron Threaded Fittings: Classes 150 and 300

2) ANSI B31.3 – Process Piping Guide

D. American Society for Testing and Materials (ASTM)

1) ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

2) ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
E. American Society of Mechanical Engineers
   1) ASME B15.1 – Mechanical Power Transmission Apparatus.
F. Institute of Electrical and Electronics Engineers (IEEE)
G. Insulated Cable Engineers Association, Inc. (ICEA)
H. National Electrical Code (NEC)
I. National Electrical Manufacturers Association (NEMA)
   1) NEMA AB 1 – Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
   2) NEMA MG 1 – Motors and Generators
J. InterNational Electrical Testing Association (NETA)
K. National Fire Protection Association (NFPA)
   1) NFPA 30 – Flammable and Combustible Liquids Code.
   2) NFPA 37 – Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
   3) NFPA 70 – National Electrical Code.
   4) NFPA 110 – Standard for Emergency and Standby Power Systems; Requirements for a Level 2 emergency power supply system.
L. Underwriters Laboratories (UL)
   1) UL 142 – Aboveground Flammable Liquid Tanks
   2) UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials
   3) UL 1236 – Standard for Battery Chargers for Charging Engine-Starter Batteries
   4) UL 2200 – Standard for Stationary Engine Generator Assemblies

2. Products
   2.1 General
      A. Engine generator manufacturer shall be approved by the CITY.
B. All materials, equipment and parts comprising the units specified herein shall be new and unused, be the current product of the manufacturer and of highest grade, free from all defects or imperfections affecting performance. Workmanship shall be of the highest grade in accordance with modern practice.

C. The design and construction of the emergency generator unit shall be neat and clean in appearance. Normal adjustments and maintenance must be accessible without the use of special tools. The engine, generator and all major items of auxiliary equipment shall be products of US. Manufacturers regularly engaged in the production of such equipment, and shall be assembled, tested and shipped to the job site by the engine/generator manufacturer or his authorized distributor.

2.2 Engine-Generator Set

A. Factory-assembled and tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. Capacities and Characteristics:

1) Power Output Ratings: Nominal ratings as indicated. The unit shall be capable of delivering kW required at installed location after consideration of applicable de-rating factors.

2) The temperature rise shall not exceed 120 degrees C over 40 degrees C ambient at its standby power rating.

D. Generator-Set Performance:

1) Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.

2) Transient Voltage Performance: Not more than 30 percent variation for 100 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3) Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.

4) Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5) Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6) Output Waveform: At no load, voltage harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics.
Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7) Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8) Start Time: 10 seconds to comply with NFPA 110 Type 10 system requirements.

2.3 Engine

A. Fuel: The engine shall be capable of full load duty when operating on the fuel type indicated.

1) Diesel Engines: Commercial grade fuel oil, Grade F-2. Engines requiring a premium grade of fuel will not be acceptable.

B. Rated Engine Speed: 1800 rpm.

C. Induction Method:

1) Generator Units ≤ 100kW: Naturally aspirated or turbocharged and aftercooled as recommended by the manufacturer and required to perform the specified duty.

2) Generator Units 100kW and above: Turbocharged and aftercooled as recommended by the manufacturer and required to perform the specified duty.

D. Lubrication System:

1) Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and larger while passing full flow.

2) Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3) Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1) Diesel Engines:

(a) Main Fuel Pump (Diesel): Pump shall ensure adequate primary fuel flow under starting and load conditions.

(b) Double poppet foot valve on main fuel pump supply connection at the base tank for pump priming.
(c) Relief-Bypass Valve (Diesel): Shall automatically regulate pressure in fuel line and returns excess fuel to source.

(d) Dual parallel fuel filters and water separators.

(e) Flexible Fuel Connectors - Flexible plastic liner with corrosion resistant type 316 stainless steel wire braid reinforced cover.

(f) Fuel Piping - Piping and fittings within the enclosure shall be Schedule 80 black steel in conformance with ASTM A53 and ANSI B31.3 with 125 lb. threaded malleable iron fittings conforming to ANSI B16.3 and ANSI B31.3.

(g) Furnish all fuel piping completely piped inside the enclosure - supply piping from the base-mounted fuel tank to the main fuel pump, supply piping from the main fuel pump to the generator, return piping from the generator to the base mounted fuel tank, and relief-bypass piping from the relief-bypass valve to the base-mounted fuel tank.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1/2 equipment for heater capacity to maintain engine jacket water at 100 degrees F in an ambient of 0 degrees F.

1) Coordinate electrical supply with installing CONTRACTOR prior to shipment.

2) Provide isolation valves at all jacket water heater lines connecting to the engine block to allow replacement of heater element or hoses without draining the engine’s coolant.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1) Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2) Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

3) The radiator shall be equipped with a blower-type fan with fan guard. The fan belts shall have provisions for tension adjustment.

4) The radiator fan shall have an external static pressure of not less than 0.5 inches of water.

5) The radiator shall incorporate flanges for the attachment of a flexible duct connection to the exhaust plenum.

I. Muffler/Silencer: Minimum Super Critical Grade, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufac-
turer's engine backpressure requirements.

1) Final silencer type (up to Super Extreme Grade) shall be selected to provide sound attenuation in accordance with the requirements of Paragraph 2.8.D below.

2) Manufactured of aluminized or stainless steel.

3) A stainless steel flexible exhaust fitting shall be installed between the engine and exhaust silencer.

4) The silencer shall be nested within the generator set enclosure (where provided) and discharge shall be directed vertically upward with a flapper-type rain cap.

J. Exhaust Piping.

1) Connect the exhaust silencer to the engine with a stainless steel bellows type exhaust flexible connector as recommended by the engine manufacturer for the maximum operating temperature of the exhaust, engine vibration, and for expansion of the exhaust system caused by a 650 deg. C temperature change. The flexible connector shall adapt to the engine exhaust outlet connection, and shall provide a flanged or threaded connection to the exhaust silencer or exhaust piping.

2) Exhaust pipe shall be Schedule 40 Type 304 stainless steel with flanged or welded fittings. Exhaust pipe shall be of the size recommended by the engine manufacturer. All exhaust line elbows shall be long radius.

3) The exhaust pipe roof penetration shall be made with an insulated Type 321 stainless steel or aluminum thimble designed to accommodate the specified exhaust pipe and allow a minimum 1-inch air gap between the thimble and the pipe. There shall be no heat conduction path between the exhaust pipe and the roof. The roof thimble shall project above the finished roof and shall include Type 321 stainless steel or aluminum exterior rain flashing and insulation as required to protect the enclosure. All portions of the exhaust system above the rain collar and exposed to the weather shall be of aluminum or Type 321 stainless steel construction. The open space between the exhaust pipe and the roof thimble shall allow for ventilation and shall include screening or mesh to prevent the entrance of insects.

4) Terminate the exhaust pipe vertically outside the enclosure with a Type 321 stainless steel counterbalanced raincap with bronze bushings. The raincap shall be weighted such that the cap will open completely out of the exhaust air flow, causing no obstruction or deflection when the engine is running at rated speed without load.

5) Cover the interior exhaust system with insulation to limit the interior temperature rise of the enclosure and shield heat sensitive components from the exhaust pipe heat, and provide operator protection in accordance with UL 2200 during generator operation. The insulation shall not contain asbestos or asbestos bearing products.
6) The insulation for the silencer shall be 4-in thick wrap insulation rated to 1200°F. The insulation for the exhaust piping shall be rigid 4-inch thick insulation rated to 1200°F. Fittings and flanges shall be insulated with pipe covering material cut to fit. Insulation shall have a thermal conductivity of 0.66 BTU-Inch/(Hour-Foot Squared-°F) at a mean temperature of 700°F. Insulation shall have a flame spread rating of 5 or less, and smoke developed rating of 0 when tested in accordance with ASTM E84 and UL 723. Insulation shall be light weight, low dust, and mold resistant.

7) Insulation shall be held in place with stainless steel banding and covered with a 0.016 or 0.020-in aluminum jacket, secured with screws and jacketing lapped a minimum of 3-in. The aluminum jacket shall be separately applied at the job site.

8) Flexible sections of the exhaust systems shall be protected by a suitable metal guard to prevent personal injury from a burn if in contact with bare flesh.

9) Furnish and install all required steel support framing and hanger bands for supporting the silencer and exhaust piping from the interior of the enclosure.

10) A suitable drain with valve shall be provided at the low point of the exhaust silencer and exhaust piping, and routed to the exterior of the enclosure.

11) The entire installation shall meet with the OWNERS approval. It is the intent of this specification to provide complete compliance with all applicable local, State and Federal codes, laws and regulations.

K. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

L. Starting System: 12 or 24-VDC electric, with negative ground. Include two lead-acid batteries complete with cables. Batteries shall be mounted inside the generator frame, adjacent to the engine.

1) Batteries and components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum.

2) Cranking Motor: Heavy-duty unit that shall automatically engage and release from engine flywheel without binding.

3) Cranking Cycle: As required by NFPA 110 for system level 1.

4) Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

   (a) Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.

5) Provide battery trays, weld in place prior to finish application.
2.4 Fuel Oil Storage (Diesel Engine Units Only)

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Double wall steel, Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1) Automatic Tank Gauging System
   (a) The automatic tank gauging system shall provide continuous monitoring of the amount of fuel in the tank, provide statistical and static leak detection, include ethernet and IP communications. The system shall be configurable to sense up to 64 sensors, allow external inputs and relay outputs, record engine run activity, and provide complete inventory reports after engine operation.

2) Capacity: Fuel for [24] hours' continuous operation at 100 percent rated power output as indicated. Tank sizing shall account for fill limiter valve limiting fuel level to 90% of tank capacity, and height of fuel supply foot valve above bottom of tank. Useable fuel capacity shall be provided for the number of hours of operation listed above.

3) Vandal-resistant fill cap (where fill location is outside of the enclosure).

4) Containment Provisions: Comply with requirements of authorities having jurisdiction.

C. The tank shall be constructed of primed/painted structural steel and be provided with venting in accordance with NFPA 30, manual fill provisions including fill port with 7 gallon spill containment and fill limiter valve, fuel level gauge, fuel tank leak/rupture gauge, low level, high level, and tank rupture alarm contacts. Tank color shall be black in color or painted to match the generator enclosure. A primary and secondary fuel filter/strainer piped in parallel shall be provided and mounted between the tank supply fitting and the engine fuel inlet. Flexible fuel lines shall be provided between all components. The tank base shall be equipped with four-point lifting provisions designed to allow safe unloading and setting of the complete generator set and tank/enclosure assembly.

D. Include provisions in fuel tank for future connection to tank monitoring system to monitor actual fuel level within the tank.

2.5 Control and Monitoring

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the “automatic” position, remote-control contacts in one or more separate automatic transfer switches shall initiate starting and stopping of generator set. When mode-selector switch is switched to the “on” position, generator set shall start. The “off” position of same switch shall initiate generator-set shutdown. When generator set is running, specified system or equipment failures or derangements shall automatically shut down generator set and initiate alarms. Include auxiliary contacts as required to indicate control system is not in automatic mode.
B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

1) All generator functions shall be fully programmable from the generator control panel (with digital display). Generators requiring external devices or software for programming functions will not be accepted.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 systems, and the following:

1) AC voltmeter.
2) AC ammeter.
3) AC frequency meter.
4) EPS supplying load indicator.
5) Ammeter-voltmeter, phase-selector switch(es).
6) DC voltmeter (alternator battery charging).
7) Engine-coolant temperature gauge.
8) Engine lubricating-oil pressure gauge.
9) Running-time meter.
10) Generator-voltage adjusting rheostat or provisions for digital control.
11) Fuel tank low level, high level, and rupture alarms (diesel engine units only).
12) Generator overload.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Provide dry contacts to signal alarms, generator failure, generator fault, or other conditions to the remote monitoring system (alarm transmitter). Coordinate contact current and voltage ratings with the remote monitoring system prior to shipment.

F. Manual Stop Station (For exterior generator installations only): Provide a generator remote emergency stop push-button to be field installed by the CONTRACTOR.
2.6 Generator Overcurrent and Ground Fault Protection

A. Generator Circuit Breaker: Molded-case, electronic trip type; 100 percent rated; complying with NEMA AB 1 and UL 489. Trip rating shall be coordinated with OWNER prior to shipment.

1) Tripping Characteristic: Designed specifically for generator protection.

2) Trip Rating: Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-adjustable electronic trip; and the following field-adjustable settings:

   (a) Instantaneous trip.

   (b) Long- and short-time pickup levels.

   (c) Long- and short-time time delay adjustments.

3) Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4) Auxiliary Contacts: Provide auxiliary contacts to indicate circuit breaker position.

5) Mounting: Adjacent to or integrated with control and monitoring panel.

6) The breaker shall be installed in a NEMA-1 enclosure within the generator set enclosure and shall be equipped with copper output bus bars to accommodate the quantity and size of conductors required for installation, plus the neutral and ground conductors as indicated. Neutral leads shall be brought out and terminated to an isolated bus bar mounted within the circuit breaker enclosure. Coordinate required lugs with OWNER prior to shipment.

7) Where an electronic trip circuit breaker with adjustable long time, short time, and instantaneous settings is installed, the generator supplier shall furnish any required human interface modules (HIM’s) for programming and setting adjustments. A HIM shall be furnished for each generator set.

2.7 Generator, Exciter, and Voltage Regulator

A. The generator output voltage and phase shall be as indicated at the time of the order, 60 Hz, AC. A three-phase voltage regulator shall be provided by the generator manufacturer matched to the characteristics of the generator.

1) All generator sets furnished with 120/240-volt delta outputs shall utilize the B-phase as the high-leg.

B. Comply with NEMA MG 1.

C. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
D. Excitation System: Provide a brushless excitation system consisting of an exciter and rotating rectifier assembly, and permanent magnet generator integral with the generator and a voltage regulator.

E. Electrical Insulation: Class H.

F. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12-lead alternator.

G. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

H. Enclosure: Drip proof.

I. Instrument Transformers: Mounted within generator enclosure.

J. Voltage Regulator: Solid-state type, three-phase sensing type, separate from exciter, providing performance as specified.
   1) Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

K. Provide an alternator anti-condensation strip heater. Heater shall be thermostatically controlled unit arranged to maintain stator windings above dew point.

L. Provide alternator with topical coating to inhibit moisture and growth of fungus.

2.8 Outdoor Generator-Set Enclosures

A. Description: Non-walk-in, vandal-resistant, weatherproof housing, wind resistant up to 110 mph. A minimum of four (4) panels shall be lockable and provide adequate access to components requiring maintenance. Instruments and control shall be mounted within enclosure.
   1) Lockable enclosure panels shall be gasketed and shall utilize stainless steel locking hardware, keyed to “CH751” unless specifically noted otherwise.

B. Where indicated, the generator set shall be enclosed in a factory installed UL2200 listed weather protective enclosure with factory applied baked on polyester powder-coat finish with UV inhibitors.
   1) Construction shall be minimum 14-gauge aluminum.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits.
   1) Extruded Aluminum Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers shall prevent entry of rain and snow. Paint to match generator enclosure.
(a) Provide bird screen on intake and discharge louvers.

D. Sound Attenuation: Manufacturer’s sound attenuation insulation shall be applied to the interior of the enclosure to meet the requirements noted below. Mount exhaust silencer within enclosure to minimize sound transmission. The unit shall produce output no more than the following:

1) Sound Attenuation: 70 dBA maximum at 23 feet.

E. Enclosure Air Intake and Exhaust:

1) Air handling during operation of the generator set shall be as follows:

(a) Air shall enter the enclosure through a sound attenuating hood and louver. Provide a motor operated damper on the intake, wired through the generator control panel to open upon engine startup.

(b) Radiator discharge shall be through a gravity operated damper and louver, into a sound attenuating discharge plenum with vertical up discharge. Furnish and install an air discharge duct from the face of the radiator to the enclosure discharge louver. Provide a flexible connection between the radiator and discharge duct.

2) The air flow restriction shall not exceed 0.5-in w.g. total external static pressure to ensure adequate airflow for cooling and combustion.

3) Intake and discharge louvers shall be of formed and extruded aluminum, and shall be screened with stainless steel bird screens. Louvers shall be AMCA 511 rated drainable blade louvers with a minimum free area of 50-percent for a 48”x48” louver section, and a minimum beginning point of water penetration of 850 feet per minute.

4) Intake louvers shall be sized based on the net louver free area such that the free area velocity does not exceed the beginning point of water penetration with a minimum 10-percent safety factor, and in no case shall the intake louver free area velocity exceed 800 feet per minute. Intake louver sizing shall include both the radiator cooling airflow and the engine combustion airflow.

5) Radiator exhaust louvers shall be sized based on the net free area of the louver with a velocity that minimizes the pressure drop/airflow restriction across the louver, while considering the overall airflow restriction noted above.

6) The sound attenuated intake hood and exhaust plenums shall be designed to limit the airflow noise and mechanical noise from the enclosure as required to conform to the noise limitation specified in Paragraph 2.8.D above. Provide sound attenuating baffles, liners, or other appropriate sound attenuating materials.

7) Motor-operated and gravity dampers shall be of formed and extruded aluminum with corrosion resistant shafts and hardware. Damper motor operators shall be arranged for a 120 Volt, 60 Hz, single phase power supply, spring to open, power
to close. Wire the damper control through the generator run contact. Pre-wire the damper power supply from the generator power distribution center.

F. The enclosure shall include hardware to internally mount the specified exhaust silencer and exhaust piping, and maintain the weatherproof integrity of the system.

G. All openings in the generator mounting skid and all air flow inlets and outlets in the enclosure shall be provided with rodent protection screens. Rodent protection screens shall consist of a punched metal panel with square openings sized to permit air flow required by the generator manufacturer. The punched metal panel openings shall be covered with aluminum or stainless steel insect/rodent screen to prevent pests from entering the mounting skid and enclosure.

2.9 Vibration Isolation Devices

A. The engine generator shall be equipped with vibration isolators of a quantity and type recommended by the manufacturer.

3. Execution

3.1 Delivery

A. When the OWNER provides the generator the OWNER will deliver the generator to the site. Offloading, including any required rigging or equipment, shall be the CONTRACTOR’s responsibility.

B. When the CONTRACTOR provides the generator the CONTRACTOR is responsible for having the generator delivered to the site. Offloading, including any required rigging or equipment, shall be the installing CONTRACTOR’s responsibility.

3.2 Installation

A. Comply with packaged engine-generator manufacturers’ written installation and alignment instructions and with NFPA 110.

1) Generator set shall be mounted on a concrete pad that is independent of all other concrete slabs or structures, unless otherwise indicated. Refer to the Contract Drawings for additional details.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance. A minimum of four (4) feet of clearance shall be provided around the perimeter of the enclosure.

C. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

1) Provide field wiring consisting of power and control wiring between the emergency generator unit and the automatic transfer switch.

2) Provide field wiring from the emergency generator unit to the alarm transmitter for the following alarm points:
(a) Generator Running
(b) Generator Trouble
(c) Generator Fault Detected
(d) Generator Low Fuel
(e) Spare

3) Provide field wiring for individual/isolated 120VAC circuits to battery charger and jacket coolant heater as indicated on the Contract Drawings.

4) Provide field wiring for (1) 20A, 120VAC, GFI-type, duplex receptacle with weatherproof while-in-use cover as indicated on the Contract Drawings.

D. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

E. Connect engine exhaust pipe to engine with stainless steel flexible connector.

F. Connect fuel piping to engines with a gate valve and union and flexible connector.

3.3 Source Quality Control
A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

3.4 Field Testing and Acceptance
A. Perform tests and inspections and prepare test reports.
   1) Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in startup and field testing. If the OWNER provides the generator then the OWNER will provide the service representative. If the CONTRACTOR is providing the generator then the CONTRACTOR is responsible for providing the service representative.

   2) The generator supplier shall furnish any required load banks for field testing.

B. Tests and Inspections:
   1) NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
2) The electric set shall receive the manufacturer’s standard testing at the factory. The factory testing shall include a reactive load bank test at 0.8 power factor. Certified copies of the factory test shall be supplied to the OWNER prior to shipping and within 10 days of completion of test. Prior to acceptance of the installation, the equipment shall be field tested to show it will start automatically, and shall be subject to full load test, shut down and reset as required in these specifications. Prior to acceptance, any defect which becomes evident during this test shall be corrected. The test shall be performed in accordance with the following minimum requirements and shall include any other tests that may be recommended by the manufacturer for the purpose of evaluation. A portable resistive (1.0pf) loadbank shall be utilized for the field test where permitted by NFPA 110. The generator shall be started and operated at a minimum 50% of rated load for a period not less than ½ hour, after which the load shall be increased to 75% of rated load and operated for the second ½ hour. The load will be then increased to 100% and held continuously for a period of not less than two hours, then operated at no load for a period of 15 minutes prior to shutting down the generator set. A full written report indicating KW output, voltage, current, frequency, oil pressure, water temperature, and ambient temperature variations taken at 15 minute intervals during the test shall be provided to the OWNER for evaluation and disposition. All tests shall be performed in the presence of the OWNER's authorized representatives and the manufacturer's representative who shall validate the report. Fuel for testing shall be furnished by the OWNER.

C. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.

D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Remove and replace malfunctioning units and retest as specified above.

G. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

H. Report results of tests and inspections in writing to OWNER/ENGINEER. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.5 Demonstration

A. Engage a factory-authorized service representative to demonstrate unit operation and train OWNER’S maintenance personnel to adjust, operate, and maintain packaged engine generators. Include a minimum of 8 hours of training time on site. If the OWNER provides the generator then the OWNER will provide the service representative. If the CONTRACTOR is providing the generator then the CONTRACTOR is responsible for providing the service representative
3.6 Screening

A. Provide visual screening for the generator set as indicated on the Contract Drawings. Screening shall consist of a shadow box style fence with minimum 6” wide slats, minimum 50% overlap and maximum 50% gap. Minimum fence height shall match the height of the emergency generator unit enclosure. Provide dry lumber in accordance with Section 06200.

END OF SECTION
Section 16630 - Automatic Load Transfer Switch

1. **General.**

1.1 **Summary**

A. This section addresses all supervision, labor, materials and equipment in the work for furnishing and installing an automatic load transfer switch as shown or specified.

B. Related Sections:

- 01600 Materials and Equipment
- 01650 Starting of System
- 16010 Electrical General Requirements
- 16050 Basic Electrical Materials and Methods
- 16620 Engine Generators

1.2 **Submittals**

A. Submit Shop drawings and manufacturer’s data in accordance with the provisions of Division I, General Provisions, and Section 01600 – Materials and Equipment.

B. Operations and Maintenance Manual in accordance with Section 01600.

C. Warranty Information

1.3 **References**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. The referenced publications shall be the current effective edition.

1) ANSI Z535 – Safety Alerting Standards

2) UL 1008 – Transfer Switch Equipment

3) NFPA 70 – National Electrical Code – Specifically, but not limited to Article 702-Optional Standby Systems

4) NFPA 70E – Standard for Electrical Safety in the Workplace

5) NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts

6) NEMA 4X, 12 – NEMA Enclosure Types

7) NEMA ICS 10 – AC Transfer Switch Equipment

8) IEEE 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
9) UL 108 – Transfer Switch Equipment
10) UL 508 – Standard for Industrial Control Equipment

1.4 Warranty

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

1) Warranty Period: Five years from date of Final Acceptance for all components.

2) All warranty work shall be performed by factory-trained generator technicians. Non-factory trained or non-generator technicians shall not be acceptable.

2. Products

2.1 Acceptable manufacturers and products must be on the Approved Product List on the City of Virginia Beach Department of Public Utilities web site or be determined by the OWNER to be an approved equal.

2.2 System Description

A. When connected to the generator set, system shall provide fully automatic operation upon receipt of a “start” signal from the automatic transfer switch. Upon resumption of normal power and after time delay of transfer switch, automatically transfer load to normal power and automatically shut down generator, returning the generator to starting condition ready for another operating cycle.

B. Automatic load transfer switch shall be rated as scheduled and shown on the Contract Drawings.

C. Transfer switches shall have insulating barriers covering all field connections and contactors to act as both arc shields and to prevent accidental contact with energized parts. It shall have fully enclosed arc chambers to provide protection to the operator against arcing, and also prevent flashover.

D. Manual operation of transfer switch shall provide the same contact-to-contact transfer speed as the electrical operator to prevent flashover. The handle shall be well isolated from electrical or mechanical hazards, and long enough to allow operation without the risk of accidental contact with energized parts. Proper instructions and labels shall be provided on the switch to assure safe operation.

E. The switch shall be listed per UL 1008 and shall have the following label: UL LISTED AUTOMATIC TRANSFER SWITCH FOR USE IN OPTIONAL STANDBY SYSTEMS. Visual markings for arc flash hazards shall be installed per ANSI Z535.

F. The transfer switch shall include the Manufacturer's standard accessory package and
exerciser with and without load.

G. The manufacturer shall furnish schematic and wiring diagrams for the particular automatic transfer switch and typical interconnection wiring diagram.

H. The automatic transfer switch shall be rated for continuous operation in ambient temperatures of -25 degrees F to +125 degrees F.

I. The transfer switch shall be rated for all classes of load, both inductive and noninductive, at 600- or 240-volts, and shall be designed, built, and tested to close on an inrush current up to and including 20 times the continuous rating of the switch without welding or excessive burning of the contacts. The transfer switch shall be capable of enduring 6000 cycles of operation, at rated current, at a rate of 6 cycles per minute, without failure. One cycle shall consist of complete opening and closing of both sets of contacts on an inrush current 10 times the continuous rating of switch.

J. The automatic transfer switch shall have terminal lugs for copper wire, and shall have individual, heat resistant chambers enclosing solid silver cadmium oxide, double-break contacts.

K. The transfer switch shall have mechanical and electrical interlocks to prevent simultaneously energizing both normal and emergency service, and shall be mechanically held both sides, with manual operator and auxiliary contacts rated 6-amps, 120-volt AC; 3-amps, 240 volt AC both sides.

L. The transfer switch shall be factory installed in a non-ventilated NEMA 4X enclosure for outdoor locations and NEMA 12 for indoor locations.

M. Provide UL listed service-entrance rated transfer switches for the emergency source input where indicated on the Contract Drawings. Switches shall be provided with overcurrent protection on the emergency source input to match the current rating of the station’s service.

N. Control accessories shall mount on a dead-front, swing-out control accessory panel to avoid shock hazard while adjusting control functions, but shall swing out exposing the wiring to facilitate servicing. Indicating lamps and meters shall be set in front mounted panel visible after opening front door of cabinet. Control accessories shall be solid state type and shall provide the following functions:

1) All automatic transfer switch functions shall be fully programmable from the control panel. Automatic transfer switches requiring external devices or software for programming functions will not be accepted.

2) 7-day programmable exerciser with “with” or “without” load selector switch.

3) 3-phase sensing of voltage and frequency of utility.

4) Voltage/Frequency relay shall be set to drop the standby power source at 90% of nominal voltage and/or frequency.

5) Monitor each ungrounded line with calibrated, dial-adjustable solid state under-
voltage and over-voltage sensors to sense a decrease or increase of voltage above/below a set point, a loss of voltage on any phase of the normal power source, or a phase rotation. Voltage sensors shall be temperature compensated for 2 percent maximum deviation over the temperature range -25 degrees F to +175 degrees F.

6) Signal the engine-generator set to start in the event of a power interruption. A solid state time delay start (adjustable from 0 to 5 minutes minimum) shall delay this signal to avoid nuisance startups on momentary voltage dips or power outages.

7) Transfer the load to generator after normal power interruption. A time delay transfer (adjustable from 0 to 8 minutes minimum) shall delay this transfer in case of short-term normal power interruption.

8) Retransfer the load to the line after normal power restoration. A time delay retransfer (adjustable from 0 to 30 minutes) shall delay this transfer to avoid retransfer in case of short-term normal power restoration.

9) Provide an automatic retransfer time delay bypass to retransfer the load from generating set to normal source if generating set output interrupts after normal source restores voltage.

10) Time Delay Programmed Transition (TDPT) – Delay the transfer from the neutral position.

11) Signal the engine-generator to stop after load retransfers to normal source. A solid state time delay stop (adjustable from 0.5 to 30 minutes) shall permit engine to run unloaded to cool down before shutdown.

12) Provide a test switch to simulate an interruption of power from the normal source.

13) Provide with a with load-without load option to select test or exercise as follows:
   (a) Without load", the generating set runs unloaded.
   (b) "With Load", the automatic transfer switch transfers load to generating set, after time delay, the same as it would for a normal source interruption.

14) Provide a control disconnect plug to electrically disconnect the control section from the transfer switch for maintenance service during normal operation.

15) Provide 4” x 6” Long PVC knock-out with cap in bottom of cabinet.

O. Provide an auxiliary relay or auxiliary contact on the main power contactors so that a remote alarm or light can be connected to indicate that power is being supplied from the engine generator set.

2.3 Cam-Lock Quick Connectors for use on stations to be connected to portable generators.

A. Provide flush-mounted connectors as scheduled and as follows:
### Connector Service Voltage

<table>
<thead>
<tr>
<th>Connector / Cap</th>
<th>Connector / Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>208V/240V (Female)</strong></td>
<td><strong>480V (Male)</strong></td>
</tr>
</tbody>
</table>

**A Phase**
- 16R22-E / 16P22-E
- 16R21-H / 16P21-H

**B Phase**
- 16R22-R / 16P22-R
- 16R21-O / 16P21-O

**C Phase**
- 16R22-B / 16P22-B
- 16R21-Y / 16P21-Y

**N**
- 16R22-W / 16P22-W
- 16R21-W / 16P21-W

**GND**
- 16R22-G / 16P22-G
- 16R21-G / 16P21-G

* The B-phase will be a high-leg when on portable generator service at 240-volts. CONTRACTOR shall ensure that the B-phase is not connected to any single-phase loads (such as lighting panels or control circuits), and make any necessary circuit modifications to accomplish such.

1) Catalog numbers indicated in schedule for phase, N, and GND are for single pole cam-type connectors, rated 400A, 600V, double set-screw style. No substitutions are acceptable for the connectors specified. CONTRACTOR shall provide each phase, neutral, and GND connector with a protective cap that corresponds to the connector being provided. Secure caps to connection box enclosure with stainless steel chains to prevent loss.

2) Mount connectors on the ATS enclosure or in the connection box enclosure as noted and/or detailed. Connect each phase and N to the appropriate pole/lug of the “emergency” source input circuit breaker or neutral lug in the connection box with a #4/0 “extra flexible” type-W cable rated for 405A. Connect the GND to the GND lug in the connection box with a #2/0 Type-W cable as specified above.

3) Coordinate final requirements and mounting with OWNER prior to ordering components, and prior to installing in connection box or connecting to ATS.

B. Provide a flush mounted outlet, Amphenol type 4-Pin receptacle, on the ATS enclosure or in the connection box, and connect to ATS control inputs. Connect the control/signal connector to the ATS with a 4-conductor type SOW-A cable to provide for remote engine start control and to transfer the switch position.

C. Auxiliary Contacts

1) One to close when normal fails (Status to PLC)

2) One to open on standby (Generator)

3) One to close on standby (Status to PLC)

4) One to close on standby (Spare)

5) One to open on standby (Spare)

6) One to close on normal (Status to PLC)
3. **Execution.**

3.1 **Installation**

A. Automatic load transfer switch shall be installed in strict accordance with the recommendations of the manufacturer and with all applicable codes and regulations. Phase rotation shall be tested prior to the installation and upon completion of the automatic transfer switch installation. Phase rotation shall be maintained for proper operation of pumping equipment.

3.2 **Testing**

A. If the CONTRACTOR provides the automatic transfer switch the CONTRACTOR shall provide the services of a factory-trained representative to assist in preparing an Operational Testing Acceptance Test Report of each station system. If the OWNER provides the automatic transfer switch the OWNER shall provide the services of a factory-trained representative to assist in preparing an Operational Testing Acceptance Test Report of each station system. Upon failure of any station system test CONTRACTOR shall repair the system and perform a complete system retest at CONTRACTOR's expense. All test reports shall be submitted to the OWNER upon completion. CONTRACTOR shall provide all the equipment necessary, including an appropriately sized and configured emergency generator where required, to perform the functional acceptance test report.

3.3 **Start-up**

A. An authorized factory-trained representative of the manufacturer shall inspect the equipment installation after it is completed, and perform the initial start-up of the system.

3.4 **Training**

A. The factory-trained representative shall train the OWNER’S personnel in proper operation and maintenance of the equipment. A minimum of two hours of training shall be included.

END OF SECTION